CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT (CHIA)

UPPER GORDON CREEK
AND
BEAVER CREEK BASINS

Horizon Mine
C/007/0020

Gordon Creek #2, #7 & #8 Mines
C/007/0016

Gordon Creek #3 & # 6 Mines
C/007/0017

Carbon County, Utah

June 13, 2005
TABLE OF CONTENTS

I. INTRODUCTION ..............................................................1

II. CUMULATIVE IMPACT AREA (CIA) .........................................................3

   Horizon Mine ..............................................................................6

   Swisher # 1 and #2; Gordon Creek #2, #7 and #8 Mines ..........7

   (Swisher, Beaver Creek, and Mountain Coal Companies) ..........7

   Gordon Creek #3 (aka Beaver Creek #3) and Gordon Creek #6 Mines (Mountain Coal Company) ............7

III. HYDROLOGIC SYSTEM .................................................................9

   Climate ........................................................................................10

   Temperature ............................................................................10

   Precipitation ...........................................................................10

   Wind .........................................................................................11

   Geology ....................................................................................11

   Stratigraphy and General Lithology .........................................11

   Mancos Shale ..........................................................................12

   Star Point Sandstone ................................................................12

   Blackhawk Formation ............................................................12

   Castlegate Formation ............................................................13

   Price River Formation ............................................................14

   North Horn Formation ............................................................16

   Structure ..................................................................................16

   Faults ........................................................................................16

IV. Hydrologic Resources in the Ground-water Cumulative Impact Area .......................................17

   Aquifer Characteristics ............................................................17

   Alluvial-Colluvial Aquifer System ..........................................19

   Water in Mines .........................................................................19

   Seeps and Springs ....................................................................21

   Ground-water Quality ............................................................21

   Surface Water ...........................................................................23

   Surface-water Quantity ..........................................................24

   Surface-water Quality ............................................................26

   Recharge ..................................................................................28

   Perched Ground-water System .............................................28

   Regional Aquifer System .........................................................29

   Stored Mine Water System ......................................................29

   Ground-water Usage .............................................................30

V. MATERIAL DAMAGE CRITERIA - RELEVANT STANDARDS AGAINST WHICH PREDICTED IMPACTS CAN BE COMPARED ..................................31

VI. ESTIMATE OF PROBABLE FUTURE IMPACTS OF MINING ON THE HYDROLOGIC RESOURCES .........................................................33

   Adverse Impacts to the Hydrologic Balance ..........................33

   Potential Changes in Ground-water Quantity .........................33

   Evaporative Losses .................................................................35

   Mine Water Discharge .............................................................35

   Change in the Potentiometric Surface ....................................37

   Inter-mingling of Aquifer Waters ...........................................40

   Surface-water Quantity ..........................................................40
TABLE OF CONTENTS

Presence of Acid- or Toxic-Forming Materials .................................................................43
Water Quality Impacts .........................................................................................................43
Increased Sediment Yield from Disturbed Areas .............................................................43
Acidity ...............................................................................................................................43
Total Suspended Solids ......................................................................................................44
Total Dissolved Solids .......................................................................................................44
Other Materials Associated with Mining .........................................................................44
Hydrocarbon Contamination ..........................................................................................45
Flooding or Stream Flow Alteration ................................................................................45

VII. MATERIAL DAMAGE DETERMINATION ....................................................................47
Adverse Impacts to the Hydrologic Balance:
Ground-water Regime .......................................................................................................47
Increased Discharge in Springs .........................................................................................48
Change in Location of Spring Discharge .........................................................................48
Increased Ground-water Recharge ..................................................................................48
Changes in Hydraulic Conductivity ................................................................................48
Surface-water Regime .......................................................................................................49
Surface-water Quality ......................................................................................................49

VIII. STATEMENT OF FINDINGS ....................................................................................51

APPENDIX A .....................................................................................................................53
REFERENCES ...................................................................................................................55
INTRODUCTION

I. INTRODUCTION

This Cumulative Hydrologic Impact Assessment (CHIA) is a findings document. It assesses the impacts likely to occur within a cumulative impact area (CIA), an area that identifies the limits mining will have any possible affect on the hydrologic regime.

Hidden Splendor Resources (HSR) submitted an amendment to the Horizon Mine MRP (May 21, 2004) to increase the permit from 711 acres to 1,577 acres. The additional acreage is the part of federal lease UTU-74804 that lies north of Beaver Creek. There are also some minor changes to the surface facilities. This is a significant revision of the mine plan.

Hidden Splendor Resources, Inc. has been the owner and operator of the Horizon Mine since March 2003, when it acquired the rights to the Horizon Mine from Lodestar Energy, Inc. through the US Bankruptcy Court for the Eastern District of Kentucky.

Lodestar Energy, Inc. received a permit to expand mine operations into the 406 acres of Federal Lease UTU-74804 located south of Beaver Creek in 2001. The CHIA was updated at that time. Knowledge of the hydrology north of Beaver Creek was not sufficient to allow permitting of the entire federal lease at that time.

The objectives of a CHIA document are to:

1. Identify the Cumulative Impact Area (CIA). (Part II)
2. Describe the hydrologic system and baseline conditions. (Part III)
3. Identify hydrologic resources in the impact area. (Part IV)
4. Identify standards against which predicted impacts can be compared. (Part V)
5. Estimate probable future impacts of mining activity. (Part VI)
6. Assess probable material damage. (Part VII)
7. Make a statement of findings. (Part VIII)

Material damage is not defined in either the Utah or Federal regulations. Criteria that are used to determine material damage to hydrologic resources in coal mining programs administered by other states or by the federal Office of Surface Mining (OSM) include:

- Actual or potential violation of water quality criteria established by federal, state or local jurisdictions.
INTRODUCTION

- Changes to the hydrologic balance that would significantly affect actual or potential uses as designated by the regulatory authority.

- Reduction, loss, impairment, or preclusion of the utility of the resource to an existing or potential water user.

- Short term (completion of reclamation and bond release) impairment of actual water uses that cannot be mitigated.

- Significant actual or potential degradation of quantity or quality of surface water or important aquifers.

The Utah Division of Oil, Gas, and Mining has prepared this CHIA. It complies with Federal and Utah coal regulations as found in 30 CFR 784.14(f) and R645-301-729, respectively. The last CHIA for the area was prepared February 23, 2001 and updated September 2004. In addition to reference sources cited, information has been garnered from the Horizon, Gordon Creek #2, #7 and #8, and Gordon Creek #3 and #6 Mining and Reclamation Plan (MRP), as well as U. S. Geological Survey and Utah Geological Survey hydrologic and geologic reports.
II. CUMULATIVE IMPACT AREA (CIA)

The Cumulative Impact Area (CIA) is shown on Figure 1. This CIA identifies the Gordon Creek - Beaver Creek area, an area where anticipated and past coal mining activities could interact to affect the surface and ground-water resources. The extent of the CIA is determined on the potential for hydrologic resources, their recharge source, and maximum offsite impacts by mining activities. Both surface- and ground-water resources are considered in the CIA.

The ground-water boundary was chosen to incorporate mined and proposed lease areas, fault systems, and potential mine expansion that could influence the hydrologic balance in the drainage where the mining activities are located and adjacent drainages.

The surface-water boundary encompasses portions of the Beaver Creek and Gordon Creek watersheds, which are part of the Price River drainage basin. Beaver Creek flows in a northwest direction and discharges into the Price River south of Colton, Utah. Gordon Creek flows east and joins the Price River north of the city of Price, Utah.

A ground-water CIA includes all areas between the anticipated mining operations and known aquifer discharge points. Ground water use is typically associated with small, local alluvial or colluvial aquifers and perched aquifers that are recharged within relatively small areas around the seeps and springs. Alluvial and colluvial systems correspond closely with the stream channels.

There is also ground water in deeper consolidated strata, which may have aquifer characteristics at least over a limited area. Lithologic variability within these rocks and geologic structure influence the amount and direction of ground-water flow. Because the consolidated strata in the Blackhawk Formation and Star Point Sandstone mostly have poor hydraulic conductivity, fractures - usually associated with faults - are important paths for ground-water transport. Faults themselves may act as either conduits or barriers to ground-water movement. There is extensive faulting in the CIA. Planned underground operations of the Horizon Mine take place almost exclusively in the Fish Creek graben.

The term *regional aquifer* is commonly used in the Book Cliffs and Wasatch Plateau Coal Fields to describe the saturated portions of the Blackhawk Formation and Star Point Sandstone [and sometimes other strata]. In such usage, regional aquifer usually refers to any ground water irrespective of quality, quantity, use, storage, flow and transport, and discharge. However, ground-water storage and movement in these areas is typically of a local or intermediate nature and the Division feels that, generally, there is little or no basis for describing these as regional systems.

Regional flow systems are recharged along basin divides and transport water to the valley bottom, passing beneath local and intermediate flow systems. There are saturated strata within Blackhawk Formation and Star Point Sandstone and a few seeps and springs that flow from them, but after evaluating the geologic and hydrologic evidence, the Division does not consider...
the saturated strata in the Blackhawk and associated formations in the Horizon Mine permit area and adjacent areas to be a regional aquifer. The Division has adhered to the definition of *aquifer* as found in the Coal Mining Rules (R645-100-200). The term *regional aquifer* has been deliberately avoided throughout this CHIA unless appropriate. The geologic cross-section shown in Osterwald, 1981 provides an illustration of regional hydrogeologic relationships.

Monitoring sites have been established to help identify characteristics of surface waters and ground waters, including possible interaction between them.

**MINING HISTORY**

Plates 3-9 and 3-10 show the location and extent of known workings of active, inactive, or abandoned underground workings, including openings to the surface, within the permit and adjacent areas, and areas within these mines that have been second mined. No previously surface-mined areas are known to exist within the permit area.

Coal mining operations began in Upper Gordon Creek drainage of the Wasatch Plateau Coal Field in the early 1920s and continued at various locations except for some brief lulls. All mining in the CIA was and will be completed underground in the Hiawatha and Castlegate A Coal Seams (Table 1) using room and pillar mining techniques. The more prominent mines in the CHIA produced more than 500,000 tons of bituminous coal. Consumers (Blue Blaze) Mines operated from 1924 until the 1940s in Consumers Canyon. The National Mine operated from 1928 until the 1950s in a canyon east of Consumers Canyon. The Sweets mine operated from 1925 to 1950 from Sweet Canyon, west and south of Consumers Canyon. The Swisher Mines operated from Bryner Canyon. The Swisher #1 Mine opened in the 1960s on the south side of Bryner Canyon. The Swisher Mines were purchased by General Exploration and shortly afterward by Atlantic Richfield Company (ARCO) in 1980. ARCO operated the Gordon Creek #3 and #6 Mines in Coal Canyon and the #2, #7 and #8 Mines in Bryner Canyon through the 1990s. Some less known mines such as the Davis, K.L. Stores, Success, Jeffer, New Ewing, and Western Mines operated in the area at various times until the early 1950s. Building remnants, debris, and coal refuse from some of those mines still remain.

Several small communities and towns such as Consumers and National sprang to life in the canyons. Consumers boasted a population of 5,000 inhabitants.

The Surface Mining Control and Reclamation Act (SMCRA), Title 95-87, became federal law in 1977. At minesites such as the Blue Blaze, National, and Swisher that operated and closed prior to passage of SMCRA, buildings, coal refuse, and debris from the abandoned mines were not required to conform to the reclamation requirements under Title V, but fell under the Abandoned Mine Lands, Title IV.

The Gordon Creek #2, #3, #6, #7 and #8 mines and the Horizon Mine were operating after passage of SMCRA and required to meet statutory operational and reclamation performance standards under SMCRA Title V requirements.

The disturbed areas of Gordon Creek #3 and #6 Mines have been reclaimed and final
bond release was granted in 1999. The Gordon Creek #2, #7 and #8 Mines are currently under reclamation, but have not received Phase 1 bond release, which comes after sealing the portals, backfilling and regrading to approximate original contour (AOC), covering the regraded area with a topsoil or substitute topsoil, roughening and preparing the surface, reestablishing drainages, and revegetating the area using an approved seed mix. Construction of the Horizon Mine covered the refuse and debris of the Blueblaze Mines.

**Table 1.**
Mines in Respective Coal Seams in the CIA.

<table>
<thead>
<tr>
<th>Castlegate A Seam</th>
<th>Hiawatha Seam</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Wattis Seam, Tabet, and others)</td>
</tr>
<tr>
<td>Blue Blaze #2 Mine</td>
<td>Sweet #1 Mine</td>
</tr>
<tr>
<td>Blue Blaze #3 Mine</td>
<td>National #1 Mine</td>
</tr>
<tr>
<td>Columbo Mine</td>
<td>Horizon (#1) Mine (Blue Blaze #1)</td>
</tr>
<tr>
<td>Gordon Creek #1 (Swisher #1)</td>
<td>Gordon Creek #3 Mine (Beaver Creek #3)</td>
</tr>
<tr>
<td>Gordon Creek #2 Mine (Swisher #2 Mine)</td>
<td></td>
</tr>
<tr>
<td>Gordon Creek #6 Mine</td>
<td></td>
</tr>
<tr>
<td>Gordon Creek #7 Mine</td>
<td></td>
</tr>
<tr>
<td>Gordon Creek #8 Mine</td>
<td></td>
</tr>
</tbody>
</table>

Utah’s Abandoned Mine Reclamation Program (also known as Abandoned Mine Lands or AML) sealed and reclaimed five of the pre-SMCRA mines in the CIA during 1986. The Gordon Creek Project reclamation consisted of sealing portals, backfilling, regrading, and revegetating the Sweet, Swisher #1, National, Success, and Jeffery Mines. AML also conducted fire suppression work on the National Mine in the early 1980s before reclamation work could begin on the National and Jeffery Mines.
Proposed and Currently Operating Mines

Horizon Mine

Coal mining in this area of the North Fork of Gordon Creek began in the 1920s when the Consumer Mutual Coal Company was organized and opened an underground coal mine in Consumers Canyon. This operation continued into the 1940s. The Horizon No. 1 Mine, permitted and owned by Hidden Splendor Resources, Inc. since 2003, received its mining and reclamation permit from DOGM in October 1996. Room and pillar mining methods are to be used in the Castlegate A and Hiawatha Seams. Production at the Horizon No. 1 Mine commenced on January 21, 1998 in an area previously disturbed for the Blue Blaze #1 Mine.

The Horizon Mine permit area includes federal coal lease UTU-74804 (1,272 acres) and fee coal owned by Hidden Splendor Resources, Inc. (305 acres). Hidden Splendor Resources has been the owner and operator of the Horizon Mine since March 2003, when it acquired the rights to the Horizon Mine from Lodestar Energy, Inc. through the US Bankruptcy Court for the Eastern District of Kentucky. Lodestar had purchased the coal lease rights from Horizon Coal Corporation/Horizon Mining, LLC, which in turn had acquired the rights from Hidden Splendor Resources. Hidden Splendor bases its right to mine coal on the bankruptcy court’s assignment of Lodestar’s rights, a Designation of Operator from Lodestar, and the federal coal lease. The Horizon Mine was issued a Right-of-Way through BLM lands in 1996, which has since been incorporated into the federal lease.

Horizon Mine is 14 miles due west of Helper, Utah (Figure 2). The mine portals are located in Portal Canyon, a northeast trending side canyon of Consumers Canyon. Portal Canyon is an ephemeral drainage that joins Consumers Canyon. Jewkes Creek flows down Consumers Canyon and discharges to the North Fork of Gordon Creek.

In 2001 Lodestar Energy, Inc. received a permit to expand mine operations into 406 acres of Federal Lease UTU-74804 located south of Beaver Creek. The CHIA was updated for this 2001 expansion. Knowledge of the hydrology north of Beaver Creek was not sufficient to allow permitting of the entire federal lease at that time.

Hidden Splendor Resources (HSR) submitted an amendment to the Horizon Mine MRP on May 21, 2004 to add the remainder of lease UTU-74804, 866 acres north of Beaver Creek to the permit. This will more than double the size of the permit area, from 711 acres to 1,577 acres, so it is a significant revision (SR) to the current mine plan that requires this update of this CHIA.

The mine permit area is located in Sections 6, 7, 8, 17, and 18 of Township 13 South, Range 8 East, Salt Lake Baseline and Meridian. The revised permit area is identified by a dark blue color outline in Figure 1. Mining is in what the mine operators have called the Hiawatha Seam, but which Dave Tabet of the Utah Geological Survey (UGS) identifies as the Wattis Seam.
Access to the minesite is via County Road 290 (formerly State Highway 139), also known as Consumers Road, which runs northwest from U.S. Highway 6 between Spring Glen and Carbonville. County Road 290 is currently paved for approximately three miles and is graded gravel for the remainder of its length. The Horizon mine permit area is approximately 11.5 miles from Highway 6, and County Road 290 continues west past the Horizon mine for approximately a mile up Bryner Canyon, where the Swisher Mines were located. Access within the permit area is from another county road that branches from County Road 290 at the Horizon permit boundary and follows Jewkes Creek up Consumers Canyon, then drops down to Beaver Creek.

Other Mines

Mining in this area dates back to the 1925 when the Sweets Mine was opened. Consumers (Blue Blaze), Sweets, and National operated mines in the Gordon Creek area from the 1920s to early 1950s. The general history of the mining in this area is well known, but detailed accounts can be confusing or even seem contradictory because of changes of mine names and ownership. The following account of past mining activity is based mainly on information from Doelling (1972) and the Horizon MRP.

Swisher #1 and #2; Gordon Creek #2, #7 and #8 Mines
(Swisher, Beaver Creek, and Mountain Coal Companies)

Swisher Coal Company opened the Swisher #1 on the south slope of Bryner Canyon in the 1960s, and #2 mine on the north slope. Swisher sold the mines to General Exploration Company circa 1960. Beaver Creek Coal Company, a subsidiary of Atlantic Richfield Company, purchased the mine from General Energy in 1969. The #1 mine was reclaimed by Utah’s AML program in 1986.

Swisher Coal Company developed two more portals up canyon in 1969 and named the mine the Gordon Creek #2 Mine. The mine connected with the Swisher #2 mine. It remained in continuous production until October 1985. Beaver Creek Coal Company opened the Gordon Creek #7 Mine in 1984, and it was mined out and sealed in 1989. Beaver Creek Coal then opened the Gordon Creek #8 Mine in November 1989, and it was mined out and sealed in November 1990. The permit area encompasses approximately 2,300 acres on federal leases U-8319 and U-53159. Mountain Coal, a subsidiary of ARCH Minerals that initiated the mine closure, later purchased the mines. Portals were sealed and equipment and buildings were removed in 1991. Backfilling and regrading began in 1995, but the Permittee has not received Phase I bond release.

Gordon Creek #3 (aka Beaver Creek #3) and Gordon Creek #6 Mines (Mountain Coal Company)

The Gordon Creek #3 and #6 Mines are located in Coal Canyon. Room and pillar mining began at the Gordon Creek #3 mine in 1969. The #3 Mine was purchased by General Exploration Company in 1973, then by Beaver Creek Coal Company in 1980. The #6 Mine
opened in 1978. Both mines shared the same surface facilities. Coal was mined by room and pillar method and continuous miner. Both mines closed in September 1983.

The portals for the National Mine workings were in Portal Canyon, southwest of the Fish Creek Graben, but most of the workings were to the north and east, inside the graben. On several occasions, development mining in the Gordon Creek #3 Mine broke into the National Mine working (Dan Guy, personal communication).

Preliminary reclamation began in 1983. The portals were sealed and backfilled. Structures were removed shortly after sealing. The surface regrading and contouring took place in 1985 and 1986. The mine went through 10 years of vegetation growth and stabilization before final bond release in 1998. The operator demonstrated through water monitoring that surface waters in the receiving streams were not being impacted from minesite runoff. The sedimentation ponds were left on-site to collect storm runoff for cattle and wildlife use.
III. HYDROLOGIC SYSTEM

The CIA is characterized by steep canyons and forested mountainous plateaus. Streams and springs tend to be perennial in the forested uplands and ephemeral in the lower, semi-arid desert floors. Vegetation varies from Grassland/Sagebrush and Desert Shrub communities at lower elevations to Spruce/Fir/Aspen and Mountain Meadow communities at higher elevations. Steep canyon lands with mixed pinon/juniper and sagebrush characterize areas north of the CIA. These communities are generally used for wildlife habitat and livestock grazing. Alluvial fans covered with desert scrub line the Price River from its confluence with Willow Creek to Helper.

Underground mining activities influence both the surface and subsurface. Underground workings can extend for miles. The mine’s surface areas are usually smaller in comparison, but exposed directly to the elements. Several of the old mine workings in the CIA were abandoned without being reclaimed, leaving unsightly coal refuse piles along the canyons. The black refuse absorbs solar energy and radiates heat, which typically hinders plant growth. The loose coal waste eroded easily due to low cohesion and inadequate stabilization from root growth. A lot of coal refuse washed down the creeks. Refuse is perched along the streambanks where the sites remain unreclaimed.

Land management activities such as oil and gas production, gazing, and logging are usually beyond the purview of the agencies that regulate coal mining; however, the activities can influence the activities of the coal mines. It is important to identify the influences of other activities and separate any of their impacts from any potential mining impacts.

Grazing, wildlife habitat, limited dispersed recreation, and timber production are other activities in the CIA. Anticipated post-mining land uses are wildlife habitat, grazing, and recreation. Water within the CIA is used for watering livestock and wildlife, mining coal, domestic supply, fisheries, and recreation. Downstream, the water is used for irrigation and industrial needs.

Logging activities along Beaver Creek in 1999-2000 caused extensive sedimentation in Beaver and Gordon Creeks. Heavy logging equipment ground soils to a powder that washed into the creeks, where the fine sediment settled over the streambeds. Heavy spring runoff made the county roads into quagmires. The logging company pushed the mud off the road into huge mounds along Jewkes Creek, and the muddy mounds easily eroded and washed down the road and Jewkes Creek to Gordon Creek, which is a protected fishery.

At a higher elevation on the county road, mud and debris washed down the county roads to a low spot where it eroded the hillside above the Gordon Creek #2 Mine. There was extensive sedimentation in the channels above the mine and along the rebuilt channels at the mine. Sediment was carried down to the sedimentation pond. The Utah Division of Water Quality and Utah Division of Wildlife Resources evaluated the impacts and expressed concern. No action was taken and no mitigation was required.
Grazing is extensive over the CIA. It has changed the riparian areas along Beaver Creek since the early 1980s. Prior to that time Beaver Creek sustained an active beaver population with several series of ponds damming the stream and supporting a willow and grass riparian habitat. The beaver were removed sometime between the mid-1980s and mid-1990s. During a site evaluation initiated by Steve Stamatakis in October 1997, who expressed concerns of subsidence and dewatering, it was found that the beaver dams had been removed and the site heavily grazed and timbered. The stream had become channelized and bank storage had been depleted.

Climate

Precipitation recording stations around the CIA are located at the Skyline Mine, the town of Price, Scofield Reservoir, and the town of Hiawatha. Climatic variations at these sites are influenced by elevation and aspect. The Skyline Mine lies in a high mountain canyon at an elevation of 8,710 ft, the town of Price lies in a river valley at an elevation of 5,700 ft, Scofield Reservoir is located at an elevation of 7,618 ft - roughly the same elevation as the Horizon Mine - in a valley west of the Horizon Mine, while the town of Hiawatha lies at an elevation of 7,200 ft. Although surrounded by monitoring stations, no station is within 6 miles of the minesite.

The closest active meteorological reporting station is located at Scofield, Utah. Climatic characterization for the mine is based on historical climate data from this station and general regional climatic information. Evaporation and infiltration rates in the proposed lease and adjacent area vary with vegetation, soil type, and time of year. Average annual potential evapotranspiration in the upper Gordon Creek and Beaver Creek area is 18 to 25 inches per year (Atlas of Utah, 1981).

Temperature

Generally, the climate of the area is temperate. Temperatures reflect a typical seasonal pattern with gradual warming beginning in mid to late-March, high seasonal temperatures in July and early August, a gradual cooling beginning in late August to early September, and seasonal lows in late-December through mid-February. According to the Western Region Climate Center (WRCC), for the period 1969 to 1984, the average monthly high temperature at Scofield was 77 °F (25 °C) in July and the average monthly low was 0 °F (-18 °C) in January. The recorded daily high temperature during this period was 88 °F (31 °C) and the low –38 °F (-39 °C). The average frost-free period in this area ranges from approximately 60 to 120 days.

Precipitation

The climate in the area is arid to semi-arid. In the Wasatch Plateau, the average annual precipitation varies between 6 to 10 inches in the valleys to over 40 inches on the mountains. According to Waddell (Waddell and others, 1981, Plate 2), normal annual precipitation in the area of the Horizon Mine is approximately 20 inches per year. About 65 to 70 percent of the precipitation occurs as snow during October-April. Summer rain showers in the mountains and high valleys may produce no recorded precipitation in the lower valleys. Brief but high-intensity thunderstorms in late summer and early fall contribute significant amounts of rainfall.
Annual precipitation at Scofield averaged 17.2 inches from 1969 to 1984 (WRCC). The majority of the precipitation occurs as snowfall during the months of December, January, February, and March. Monthly average precipitation ranged from 0.85 inches in June to 1.87 inches in January, and highest average monthly snowfall was 32 inches in January.

Much of the precipitation is lost to runoff, evaporation, and sublimation, therefore minimizing the amount of water available for ground-water recharge. Price and Arnow (1979) estimated probably less than 5% of the precipitation recharges the ground-water system, which would be 0.6 to 1 inch per year. Recent studies in Australia (Barnes and others, 1994) and at the Nevada Test Site (French and others, 1996) indicate that recharge is not a linear process in arid and semi-arid environments, but rather there are threshold conditions involving the soil and the amount, rate, and timing of precipitation that must be met before recharge occurs; therefore, average annual precipitation alone may not accurately predict recharge and there may be years with precipitation but no recharge.

Wind

General regional information indicates that prevailing winds are from the west and northwest, and average wind velocities generally do not exceed 20 miles per hour. During the winter the prevailing wind direction can shift for extended periods and blow from the northeast. Exposure of plateau and ridgeline areas may produce higher wind velocities than in more sheltered slope, basin, and valley areas. Surface air movements are strongly affected locally by natural drainage patterns and diurnal temperature variations (up and down canyon winds).

Geology

The area is characterized as deeply incised plateau topography, with flat-topped ridges that rise above adjacent high desert lands. Moderately nonresistant fine-grained clay and siltstone units interfinger with resistant sandstone units. Erosion produces moderate to steep weathered slopes interspersed with vertically exposed resistant ledges and cliffs. The region’s characteristic high topographic relief incised by steep-walled canyons is the result of extensive erosion along zones of weakness. Surface elevations vary from 5,500 ft to 9,000 ft within the CIA, with the thick sandstones of the Blackhawk and Castlegate Formations forming most of this relief.

Stratigraphy and General Lithology

General stratigraphy is shown in Figure 3. In ascending order the strata exposed in the area are the Masuk Shale member of the Mancos Shale, the coal-bearing Blackhawk Formation, the unconformably overlying Castlegate Sandstone, the Price River Formation, and the North Horn Formation. Quaternary colluvium and alluvium are found on benches and along valley bottoms.

Lithology of the Book Cliffs and Wasatch Plateau Coal Fields results from the thick, relatively uninterrupted accumulation of sediments through the Upper Cretaceous and early Tertiary (Table 2). The Upper Cretaceous sediments of the section were deposited along the
western margins of a north-south oriented interior seaway. A rapidly rising mountain belt to the west supplied clastic material for shoreline construction in wave-dominated delta systems. Throughout Cretaceous time this seaway underwent a series of onlap (transgressive or seaway advancing) and offlap (regressive or seaway retreating) phases that deposited a number of broad delta and prodelta sheet sandstones. These sandstone tongues thicken westward and grade into back barrier, coastal and delta plain, and finally continental deposits. To the east (seaward), there is a thinning of the sandstone units and a fining of sediment sizes.

Major coal deposits found in Utah are usually on top of the offlap delta deposits, immediately landward of shoreline delta sandstone pinchouts. Coals that formed on these delta sandstone sheets are often very planar and continuous. Relatively short-term transgressive-regressive events commonly invaded the swamp systems and left interdeltic features such as storm washover fans, tidal inlet deltas, and lagoonal muds. Landward of the shoreline coal accumulations, delta plain depositional influences such as splays, small channels, and levee deposits have generally created a series of splits in the coal section. Coal seams formed in the delta plain or lower coastal plain are much more likely to exhibit rolls or undulations, scouring by fluvial channels, and discontinuous or lenticular geometry. Coals deposited in these environments are often thinner due to decreased time available for peat deposition.

Mancos Shale

The Mancos Shale is exposed in the lower canyons of the CIA. It consists primarily of medium gray to bluish gray marine shales and siltstones interbedded with sandstones and minor amounts of limestone. The Mancos Shale, which forms the valley floor and lower slopes of the prominent cliffs, is over 4,000 ft thick in the area. The Masuk Shale, the uppermost member of the Mancos, grades upward into the basal sandstones of the Blackhawk Formation, and westward thinning wedges of Mancos Shale intertongue with these sandstones. The Mancos is a clay-rich unit and the shale beds are good aquicludes, with low horizontal and vertical permeabilities even near faults.

Star Point Sandstone

The Star Point Sandstone, the basal unit of the Mesa Verde Group, is about 440 ft thick in the CIA. The Star Point consists of interbedded cyclic layers of sandstones and Mancos Shale. The three dominant, massive sandstone tongues are identified as the Panther Canyon, Storrs, and Spring Canyon Sandstone Members. The Spring Canyon tongue lies immediately below the Hiawatha Coal Seam.

Blackhawk Formation

The base of the Blackhawk Formation is locally comprised of five cliff-forming sandstone members: the Panther, Storrs, and Spring Canyon (the Sunnyside Sandstone) and the Aberdeen and Kenilworth Sandstones, in ascending order. The basal Blackhawk sandstones were deposited in a barrier-beach environment and intertongue with the Mancos Shale below. The sandstone tongues thicken westward and grade into the back-barrier, coastal plain, and deltaic deposits of the Blackhawk Formation. The Panther, Storrs, and Spring Canyon Sandstone Members merge to the west into one massive sandstone unit, up to 1000 ft thick, called the Star...
Point Sandstone. Lithologies are usually comprised of gradational sorted sandstones; medium-grained and cross-bedded at the top and fine-grained to silty at their base. These sandstones are generally poor aquifers, due in part to low permeability shale lenses, but ground-water transmission is greatly enhanced where these rocks are faulted, fractured, and jointed.

The aggregate thickness for the Blackhawk Formation in the area is roughly 900 to 1,400 ft. The Blackhawk Formation is the primary coal-bearing formation in the Book Cliffs and Wasatch Plateau Coal Fields. The important coal seams occur in the lower 500 ft. Thick and laterally extensive seams are closely associated with shoreline barrier-beach sands. Resting on and landward of the barrier-beach sandstones are lenticular sediments including reworked tidal channel-fill sandstones, fluvial sandstones, mudstones, siltstones, claystones, and coals deposited in back-barrier, lower coastal plain, and deltaic environments. Claystones contain high percentages of montmorillonite and other swelling clays.

There are two coal seams of economic interest at present. These are the Castlegate A Seam, Figure 4, which lies above the Aberdeen Sandstone Member of the Blackhawk Formation and the Hiawatha Seam (Wattis, after Tabot 1999), Figure 5, sits directly on the Star Point Sandstone.

(Recent geologic evaluation of the coal seams by personnel of the Utah Geological Survey presents an updated nomenclature of the coal seams in the northern Wasatch Plateau. David Tabet and others (1999) present a revised stratigraphic sequence to the commonly identified Hiawatha Coal Seam. They report that it has been common practice to name the basal coal seam lying above the Star Point Sandstone the Hiawatha coal seam. Their study shows that the commonly identified Hiawatha Seam correlates with the Axel Anderson Seam in some places and the Cottonwood Seam in other places.)

Fluvial channel sandstones are found in the lower Blackhawk but are more frequent toward the top of the formation. These sandstones are local in extent, generally fine grained, and well cemented. They have localized high clay content. The discontinuous character of these channel sandstones and the abundance of clay throughout the Blackhawk Formation produce perched aquifers and favor formation of local flow systems that discharge through numerous seeps and springs.

Castlegate Formation

Unconformably overlying the Blackhawk Formation are the massive cliff-forming sandstones of the Castlegate Sandstone. This formation is characterized by fluvial sands, probably deposited in a braided stream environment that progressed seaward over the deltaic and coastal plains (Van de Graff, 1982). The Castlegate Sandstone is good aquifer material, with seeps and springs common at the Castlegate-Blackhawk contact. In the Price River area the Castlegate Sandstone can be subdivided into three generic members with an aggregate thickness of about 630 ft. The Castlegate Sandstone is the remnant of coastal and fluvial deposition during a rapid retreat of the Upper Cretaceous Seaway in the area. The Castlegate Sandstone is exposed along the ridge in the northern part of the CIA. Tertiary rocks of the Wasatch Group form the uppermost exposures in areas south of the CIA.
Price River Formation

The Price River Formation overlies the Castlegate Sandstone. This formation consists of fluvial pebble conglomerates and coarse-grained sandstones. The remainder of the Price River Formation is comprised of fine-grained sandstones and slope-forming mudstones and siltstones totaling approximately 650 ft in thickness.
Table 2 - Generalized Stratigraphic Section

<table>
<thead>
<tr>
<th>System</th>
<th>Series</th>
<th>Stratigraphic Unit</th>
<th>Thickness (ft)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TERTIARY</td>
<td>Paleocene</td>
<td>Flagstaff Limestone</td>
<td>200 - 1,500</td>
<td>Dark yellow-gray to cream colored, dense, cherty, lacustrine limestone with thin interbeds of gray and gray-green shale. Minor amounts of sandstone and volcanic ash, with pink calcareous siltstone at the base in places. Ledge former. Many springs originating from this unit have large discharge rates shortly after snowmelt with rapid decrease, indicating large transmissivity and small storage capacity characteristic of solution-cavity ground-water systems.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>North Horn Formation</td>
<td>500 - 2,500</td>
<td>Variegated shale and mudstone interbedded with sandstone, conglomerate, and limestone, all of fluvial and lacustrine origin. Ledge former. Many springs originate where low permeability layers intersect the land surface, indicating perched ground-water systems.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Lower Wasatch)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Price River Formation</td>
<td>500 - 1,000</td>
<td>White to gray, gritty, calcareous to argillaceous sandstone interbedded with subordinate carbonaceous shale and conglomerate. Ledge and slope former.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Castlegate Sandstone</td>
<td>100 - 500</td>
<td>Coarse-grained fluvial sandstone, pebble conglomerates, and subordinate zones of mudstone. Cliff former. High permeability but largely unsaturated. Seeps and springs with seasonal variability are common.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Member</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blackhawk Formation</td>
<td>900 - 1,400</td>
<td>Fine to medium grained, thin to thick bedded, massive fluvial channel sandstone, alternating with subordinate siltstones, carbonaceous shales and mudstones, and coal. Fluvial channel sandstones are more common in the upper portion. Thick, discontinuous coal seams in the lower 500 ft. Slope former with sandstone ledges. Poor aquifer material even where faulted due to the discontinuous nature of the channel sands and the swelling properties of the shales. Relatively low transmissivities. Springs have seasonal variability. In-mine flows of up to 200 gpm with rapidly decreasing discharges. The lower Blackhawk and Star Point are considered to be one aquifer.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kenilworth, Aberdeen,</td>
<td>90 - 1,000</td>
<td>Fine to medium grained, massive, moderately well sorted coarsening upward sandstones. Cliff forming. Subordinate siltstones and carbonaceous shale. Intertongues with the Mancos Shale below and the Blackhawk Formation above. Uppermost portion contains fluvial channel sandstones. Generally poor aquifer material yielding &lt; 10 gpm. Springs have low seasonal variation, indicating large aquifer storage coefficient. Transmissivities are relatively large where rock is fractured and faulted with yields up to 300 gpm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*Spring Cyn., *Storrs,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>and *Panther Sandstones</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(*Star Point)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Masuk Shale</td>
<td>300 - 1,300</td>
<td>Slope forming sandy marine shales interbedded with sandstones and minor amounts of limestone. Grades upward into and intertongues with the overlying Star Point Sandstone. A good aquiclude.</td>
</tr>
</tbody>
</table>

Deposition of the upper Price River Formation took place from southwest to northeast. This indicates major reorientation of area drainage patterns between the periods represented by the Castlegate Sandstone and the Price River Formation, and the contact appears unconformable at some locations.

After Doelling, 1972
North Horn Formation

The North Horn Formation, the youngest consolidated rocks exposed within the CIA, has a total thickness of about 2,400 ft. This unit mainly consists of basal mudstones (170 ft), a middle zone of sandstones (860 ft), mixed thin limestones and claystones (330 ft), and an upper 1,000-foot sequence of sandstones and limey sediments. Lenticular, cliff-forming (10 ft) sandstones comprise about 10 to 15% of the section. The basal mudstones represent the uppermost of the Mesozoic strata in the area. Tertiary (Paleocene) fluvial and lake deposits form the remainder.

Structure

Faults

Generally, the CIA lies within the transition between the Book Cliffs and the highly fractured strata of the Wasatch Plateau. The area is generally broken into two major folds and two systems of high angle normal faults that are NS and WNW-ESE trending. The northern part of the CIA dips gently NW-NE associated with the Beaver Creek Syncline. To the south rocks dip east and west off the Gordon Creek anticline.

The CIA contains three major fault zones: the Pleasant Valley, North Gordon, and Fish Creek Fault zones. The Gordon Creek fault zone trends north-south, and the Fish Creek fault zone trends north 60 degrees west. The faulting appears to have influenced the development of Gordon Creek and the locations of springs and seeps in the permit area. Faulting and fracturing provide conduits for surface water to enter the ground water and allow movement between aquifers. The other major structural feature potentially controlling ground-water occurrence is the Beaver Creek Syncline trending NE-SW with dip at approximately 3.5 degrees.

The Fish Creek Fault Zone forms a graben that trends northwest - southeast. The Coal Canyon Fault has a displacement of approximately 600 ft and forms the eastern boundary for the Gordon Creek #3 and #6 Mines. Similarly, an unnamed fault with 120 ft of displacement forms the southwest boundary for the Gordon Creek #2 Mine. Numerous smaller faults with displacement of approximately 3 to 40 ft were encountered in the Gordon Creek Mines. Mine maps from the Gordon Creek Mining and Reclamation Plan show northwest trending and north-south trending faults were encountered in the mines.
IV. Hydrologic Resources in the Ground-water Cumulative Impact Area

Aquifer Characteristics

A principal factor influencing the distribution and availability of ground water is geology. Lithology and structure will affect the presence of ground water and the location and rate of its discharge. The Castle Gate and upper zone of the Blackhawk produce a significant number of springs in the CIA. The Price River Formation and the Star Point Sandstone, and the Price River-Castlegate and Castlegate-Blackhawk contacts also yield spring discharge although at a lower frequency. Some discussions of the Blackhawk-Star Point strata identify these as an important regional aquifer; however, although these strata are widespread and continuous, ground-water storage and movement is typically on a local or intermediate scale and the Division feels that there is no basis for designating these strata as a regional aquifer.

The Star Point Sandstone consists of the Panther (lowest), Storrs, and Spring Canyon (highest) Sandstone Members. The Spring Canyon Member is composed of fluvial shales siltstone and channel sandstones. The Star Point is approximately 900 ft thick in the Gordon Creek area. Recharge to the Star Point occurs primarily from vertical movement through the Blackhawk. Unfractured Blackhawk lithologies have low hydraulic conductivities, but the vertical permeability from fractures is significant.

The Hiawatha Coal Seam in the Blackhawk Formation directly overlies the Star Point Sandstone. This seam is expected to produce water during mining. Removing coal from this zone will most likely lower the potentiometric surface of the Star Point.

The floor of the Castle Gate A Seam is carbonaceous silty shale to fine grained fluvial sandstone. The roof consists of carbonaceous silty shales over 80% of the permit area and the remaining 20% consists of fluvial channel sandstones that initially produce water then tend to dry up. The general channel trend is NE-SW and the channels tend to increase in frequency to the West.

The Aberdeen Sandstone overlies the Castle Gate A Coal Seam. Drill logs indicate this sandstone member is discontinuous over the CIA. The sandstone is interbedded with siltstones and shales. This sandstone is not anticipated to be a significant aquifer because it has a thin interbedded lithology and only one spring in the CIA may issue from this formation. According to information provided in the plan for the Gordon Creek #2, #7, and #8 Mines, the Aberdeen Sandstone is under artesian pressure near the junction of Jump Creek and Beaver Creek. This is on the north side of the fracture bounding the region proposed for mining.

Other strata that overlie the coal seams and have aquifer characteristics include the Castlegate Sandstone, the Price River Formation and unconsolidated alluvial and colluvial sediment deposits. The Castlegate Sandstone is exposed in the central and northeastern section of proposed mining and is approximately 300 ft thick in the Gordon Creek area. The Price River Formation overlies the Castlegate Sandstone and occurs in the northeastern portion of the permit area.
Table 3 – Hydraulic Properties of Strata in the Wasatch Plateau Coal Field

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Price River</th>
<th>North Horn</th>
<th>Blackhawk</th>
<th>Star Point</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cm/sec</td>
<td>cm/sec</td>
<td>cm/sec</td>
<td>cm/sec</td>
</tr>
<tr>
<td>Ss</td>
<td>5.3x10⁻⁶</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silt</td>
<td>3.3x10⁻⁶</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ss</td>
<td>3.9x10⁻³</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shale</td>
<td>3.9x10⁻¹²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silt</td>
<td>7.0x10⁻¹³</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ss</td>
<td>1.3x10⁻⁸</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silt</td>
<td>4.2x10⁻¹²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ss</td>
<td>1.4x10⁻⁴</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silt</td>
<td>7.8x10⁻⁷</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ss</td>
<td>5.3x10⁻⁶</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ss</td>
<td>1.3x10⁻⁶</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silt</td>
<td>4.2x10⁻¹¹</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ss</td>
<td>1.4x10⁻⁴</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silt</td>
<td>7.8x10⁻⁷</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

USGS Lab Measurements on Cores (Lines, 1985)

<table>
<thead>
<tr>
<th>Cores</th>
<th>Price River</th>
<th>North Horn</th>
<th>Blackhawk</th>
<th>Star Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-6 27bda</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17-6 27bda</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

USGS Recovery or Drawdown Test (Lines, 1985)

<table>
<thead>
<tr>
<th>Cores</th>
<th>Price River</th>
<th>North Horn</th>
<th>Blackhawk</th>
<th>Star Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-6 24dcd</td>
<td>2.2x10⁻⁴</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17-6 27bda</td>
<td>8.6x10⁻⁸</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17-6 28bad</td>
<td>1.1x10⁻⁴</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17-6 34da</td>
<td>7.5x10⁻⁴</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-6 4bac</td>
<td>1.07x10⁻⁴</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Genwal Mine Slug Tests

<table>
<thead>
<tr>
<th>Mine</th>
<th>Price River</th>
<th>North Horn</th>
<th>Blackhawk</th>
<th>Star Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panther Tongue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MW-1 (1987)</td>
<td>3.5x10⁻⁴</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MW-4 (1992)</td>
<td>2.1x10⁻⁴</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MW-5 (1992)</td>
<td>8.8x10⁻⁴</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MW-2 (1997)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MW-6a (1997)</td>
<td>1.3x10⁻⁴</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MW-7 (1997)</td>
<td>2.2x10⁻⁴</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panther Tongue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MW-6 (1997)</td>
<td>1.9x10⁻⁴</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hansen Associates, 1979, p. 85

<table>
<thead>
<tr>
<th>Mine</th>
<th>Price River</th>
<th>North Horn</th>
<th>Blackhawk</th>
<th>Star Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trail Mountain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TM-3</td>
<td>5.1x10⁻⁴</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bear Canyon Mine Slug Tests

<table>
<thead>
<tr>
<th>Mine</th>
<th>Price River</th>
<th>North Horn</th>
<th>Blackhawk</th>
<th>Star Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panther Tongue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DH-1A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DH-2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DH-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Storrs Tongue

<table>
<thead>
<tr>
<th>Mine</th>
<th>Price River</th>
<th>North Horn</th>
<th>Blackhawk</th>
<th>Star Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>DH-1A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DH-2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DH-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Spring Cyn

<table>
<thead>
<tr>
<th>Mine</th>
<th>Price River</th>
<th>North Horn</th>
<th>Blackhawk</th>
<th>Star Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>DH-1A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

cm/sec = hydraulic conductivity cm²/sec = transmissivity
Falling–head permeability tests of the Mancos Shale at the Deer Creek Mine Waste Rock Storage Facility yielded values of 0.0 ft/yr for unweathered, unfractured shale and 0.0 ft/yr to 820 ft/yr (7.9x10^{-4} cm/sec) for weathered shales and mudstones.

**Alluvial-Colluvial Aquifer System**

The alluvial-colluvial aquifer system consists of shallow, unconfined ground water in the limited alluvial and colluvial deposits associated with surface drainage in the area. These aquifers are closely tied to the surface-water systems, with ground-water recharge occurring during periods of high flow and ground-water discharge becoming more pronounced during periods of low flow as stream levels drop below the water table. Bedrock aquifer systems may also be a source of recharge to the alluvial-colluvial systems. Unconsolidated deposits occur along valley floors and at the base of steep slopes. The thickest alluvial deposits in the permit area occur along Beaver Creek.

**Water in Mines**

The Gordon Creek #6 Mine was developed into the Castle Gate A Seam and the only water encountered is reported to have issued from channel sands exposed in the roof. The rate of discharge was described as dripping with no measurable inflow. Some of the formations may tend to appear dry because they lose water to fracture systems. The Gordon Creek #2, #7 and #8 Mines did not produce enough mine water to be discharged.

Much of the Gordon Creek #3 Mine was extensively developed in the Hiawatha Coal Seam. The portals of the Beaver Creek Coal Company Gordon Creek #3 Mine were located in Coal Canyon, and initial mine development was within the Fish Creek Graben (Figure 3; Figure 6-2 of the Horizon MRP). Mining proceeded to the south and west until stopped by a 40-ft fault at the edge of the Fish Creek Graben. Mining to the northeast, the workings crossed a graben or fault zone where offsets were on the order of 12 to 14 ft (from descriptions provided, it isn’t clear if this was the northeast boundary of the Fish Creek Graben or a separate fault system, but mine workings crossed the northeast bounding fault of the Fish Creek Graben and extensive mining was done on the upthrown side of the fault). The mine had been dry before reaching this
faulted area, but then water began to flow through the mine floor at approximately 400 gpm as the workings were advanced. During retreat mining the faulted zone was dry.

In the Gordon Creek #3 Mine, water was produced from the roof, floor, and face but inflows at a given location dried as the face advanced. Additional water occurred along intrusive dikes, where the coal was coked, creating a more permeable zone. Earlier mining by Swisher Coal and Beaver Creek Coal Companies may have dewatered surrounding strata, providing a relatively dry mining condition for the Gordon Creek Mine.

The intent was to avoid the water-bearing fault in the Horizon No. 1 Mine. Soon after mining began, it became evident that more water was entering the mine than was expected from dewatering of the Blackhawk Formation. It was concluded that the old Blue Blaze #1 workings, connected to the Horizon Mine, had intercepted a fault, the same or similar to the one that produced the high inflow to the Gordon Creek #3 Mine, and this fault was conveying a large volume of water into the mine. As the Horizon No. 1 North Mains and adjacent panels were advanced in 2000 – 2002, they encountered the same water-bearing fault. It initially produced 450 gpm, but inflow dropped to 200 to 300 gpm within two months. When mining ceased in 2002, water continued to be pumped from the mine at 294 gpm, and in 2003 this dropped to 269. When mining resumed in August 2003, an estimated 30 gpm was flowing from the working face. As the face advances, water ceases to flow into the mine approximately 100 ft back from the active face. The Horizon Mine anticipates flow from the mine to increase to as much as 500 to 600 gpm whenever the water-bearing fault is initially encountered, diminishing to an average flow of 200 to 300 gpm.

Currently a large volume of water seeps from the hillside at the junction of Coal Canyon and the North Fork of Gordon Creek. This may be associated with a fault system. It is not known if there is a connection between the Gordon Creek #3 and #6 Mines and the spring. A vegetation change has occurred in an area below the Gordon Creek #3 Mine within the past 10 years. The area at the mouth of the canyon, on the northwest side, has been saturated with water, which has killed a large stand of aspen trees. It is undetermined why the trees have died; however, some speculate that water draining from the reclaimed mine now saturates the area and that is why the trees have died.

Swisher Coal Company pillared the Castlegate A Seam beneath Beaver Creek in January 1978. Overburden thickness was about 650 feet. In September 1981, Beaver Creek Coal Company pillared the A Panel in the Gordon Creek #2 Mine beneath Beaver Creek, where overburden thickness was approximately 425 feet. Neither of these areas has shown any measurable effect on Beaver Creek (Section 3.4.8.4 of the Horizon MRP). [Note: It was reported in an earlier CHIA for this area that there was generally a greater amount of ground-water inflow to the Gordon Creek #2 Mine where there was less than 100 feet of overburden. Also, that a significant ground-water inflow took place when mining occurred where the operations encountered a fault under Beaver Creek, where overburden thickness was 500 ft. Water flowed into the mine at a rate of 20 to 40 gpm and was considered to be associated with the down-dropped side of the fault. Overall, ground water intercepted did not meet in-mine water supply needs and water was pumped into the mine from Sweet Canyon. In preparing the 2005 update of the CHIA, no information could be located to confirm any of this.]
A 100-foot fault lies adjacent to Gordon Creek #2 mine portal. On the opposite side of the fault is a spring with less than 1 gpm flow. According to the Gordon Creek #3 and #6 MRP, mining up to the fault did not produce significant amounts of water from the fault.

No information on in-mine ground water was available for the abandoned Sweets Mine. Surface drainage from the North Fork of Bryners ponded behind the Gordon Creek #2 mine yard, with no observable point of discharge. It has been hypothesized that this water was seeping into the Old Sweets Mine via subsidence tension cracks. Also, a spring is located where the fault zone in Sweets Canyon intersects the region of the suspected subsidence tension cracks. The fault zone is hypothesized to be the hydraulic connection between inflow to Sweets Mine and the discharge to Sweets Canyon.

The Horizon mine has developed wells in the Spring Canyon Sandstone Member of the Star Point Sandstone. The hydraulic conductivity of the Spring Canyon Sandstone was found to be 16.1 ft/day \((5.7 \times 10^{-3} \text{cm/sec})\) in the fractured portion of the formation as found in HZ-95-1. The hydraulic conductivity of well HZ-95-2 was 0.25 ft/day \((8.8 \times 10^{-5} \text{cm/sec})\) and HZ-95-3 was 0.20 \((7.1 \times 10^{-5} \text{cm/sec})\).

Seeps and Springs

There are several springs in the vicinity of Beaver Creek and Jump Creek, Figure 6. The majority of the springs in the CIA are associated with the Blackhawk Formation. Several springs were identified as being related to faults. Jewkes Creek is fed by two springs - a perennial spring at the head of Consumers Canyon is thought to be fault related and another small spring at the fork between Consumers Canyon and Bryner Canyon. The flow coming from the later spring is intermittent. Perennial and intermittent springs appear in the Beaver Creek - Jump Creek area. Springs occur where the recharge potential from alluvium and sandstone units in the Price River Formation and Castlegate Sandstone or from fractures created by faulting is high. Ephemeral springs tend to be linked to shallow aquifers consisting of soils, alluvium or colluvium.

Ground-water discharge from the Consumers Canyon produced 200 gpm in September 1983, a high snowfall year, but 5 gpm is a representative discharge from the springs. The Gunnison Homestead and Sweets Canyon spring are also fault related.

The operators of the mines have provided information on water rights. Most springs in the Beaver Creek and Jump Creek area are used for stock watering. Seeps and springs will be monitored in accordance with the Ground-water Monitoring Plan in Chapter 7 of the Horizon Mine’s MRP.

Ground-water Quality

The ground-water quality of the upper Cretaceous sediments in the Wasatch Plateau is characterized by total dissolved solids (TDS) contents of less than 1,000 mg/L. The following range of TDS measured in springs, wells, and mines issuing from or completed in formations found in the permit and adjacent areas as reported for the Wasatch Plateau and Book Cliffs areas by Waddell and others. (1981):
Price River Formation 122-792 mg/L  
Castlegate Formation 315-806 mg/L  
Blackhawk Formation 63-796 mg/L  
Star Point Sandstone 355-391 mg/L

Springs from the Blackhawk Formation are a calcium-bicarbonate type. Concentrations of TDS tend to vary inversely with flow, and pH of the waters is generally somewhat alkaline. Table 4 contains selected water quality data collected by mine operations and included in the Horizon mining and reclamation plan.

Table 4.  
Selected Spring Sampling Summary  
(Summary of information from portions of the Horizon Mine Plan)

<table>
<thead>
<tr>
<th>Sampling Point</th>
<th>Monitoring History</th>
<th>Location (Formation)</th>
<th>Water Quality</th>
<th>Water Quantity</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP-1 1989 to present</td>
<td>Station #1 1989 through 1993</td>
<td>Issues from Hillside and flows into Jewkes Creek (Blackhawk Sandstone unit above coal seams 8195 ft)</td>
<td>TDS 230-330 mg/L</td>
<td>Late Spring 10-15 gpm High flow on 5/89 was 45 gpm Late Summer/Fall 5 to 6 gpm</td>
<td></td>
</tr>
<tr>
<td>SP-2 1989 to present</td>
<td>Station #2 1989 through 1993 (This description matches the station number 1 previously; Channel in North Fork of Gordon Creek.)</td>
<td>Issues from Hillside and usually flows approximately 100 ft (Blackhawk, 8005 ft)</td>
<td>TDS 480-540 mg/L</td>
<td>Flow in Late Spring 1-2.5 gpm Flow in Late Summer/Fall 1 &lt;1 gpm Dry 7/1991, 8/1991, through 12/1992</td>
<td>Spring flows through alluvium below the point of origin.</td>
</tr>
<tr>
<td>SP-4 1989 to present</td>
<td>#4 1989 through 1993</td>
<td>Jewkes Creek Drainage flows along road empties into Jewkes Creek (Blackhawk, 8102 ft)</td>
<td>TDS 350-480 mg/L</td>
<td>Flow in Late Spring 1-2.25 gpm Flow in Late Summer/Fall 1 &lt;1 gpm</td>
<td></td>
</tr>
</tbody>
</table>
## HYDROLOGIC RESOURCES

### Upper Gordon Creek

<table>
<thead>
<tr>
<th>Sampling Point</th>
<th>Monitoring History</th>
<th>Location (Formation)</th>
<th>Water Quality</th>
<th>Water Quantity</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP-6</td>
<td>1989 to 1995</td>
<td>Upstream from the proposed mine portal (Blackhawk)</td>
<td>N/A</td>
<td>Dry from 1989 through 1995</td>
<td>This location is not a spring and will not be included in future monitoring</td>
</tr>
<tr>
<td>2-6-W</td>
<td>Gunnison Homestead Spring</td>
<td>Tributary to Beaver Creek near confluence of spring discharge channel and Beaver Creek (Blackhawk)</td>
<td>Not discussed</td>
<td>3-136 gpm The 136 gpm included snowmelt runoff.</td>
<td></td>
</tr>
<tr>
<td>SP-9</td>
<td>Jewkes Spring USGS 1979-1983 Station 2-5-W Beaver Creek Coal Company 1985-1995</td>
<td>Near Beaver Creek Channel, southwest corner of proposed LOM permit area. (Blackhawk, 8550 ft)</td>
<td>TDS 240-300 mg/L pH 7.5 - 8.5</td>
<td>Typical Late Spring flow 20 to 60 gpm decreasing late fall 1.10 to 38 gpm (Maximum flow on 7/85 was 1,372 gpm considered spurious).</td>
<td>Location mapped on Figure 7-3, MRP Information on flow discussion in Section 7.2.2.2 varies from Section 7.1.2.2</td>
</tr>
</tbody>
</table>

Two water quality samples were collected in the Blue Blaze No. 1 Mine workings, in May 1992 and one in November 1995. The water was determined to be a calcium bicarbonate type with TDS ranging from 414 to 452 mg/L and pH from 6.8 to 7.66. Ground-water samples collected in-mine at the Horizon #1 Mine in 1995 and 1996 show pH ranging from 7.38 and rising to 8.36, with specific conductance ranging from 485 to 595 ohms.

### Surface Water

The CIA lies within the Price River Basin, Figure 7. Major drainages within the CIA are Beaver Creek north of the mine site, and the North Fork of Gordon Creek and Gordon Creek...
HYDROLOGIC RESOURCES

south of the mine site. They drain into the Price River, which is tributary to the Green and Colorado Rivers. The disturbed area drains into the North Fork of Gordon Creek.

Beaver Creek has a drainage area of approximately 16,700 acres. Smaller drainage basins in the Beaver Creek Drainage include Jump Creek, Sand Gulch, Johnston Creek, and unnamed perennial, intermittent and ephemeral drainages. Johnston Creek is at the downstream boundary of the CIA.

Beaver Creek is a perennial stream with base flow maintained by seeps and springs. Beaver ponds are common in Beaver Creek (although not as numerous as in the past: beaver were removed sometime between the mid-1980s and mid-1990s) and also play a part in maintaining perennial flows. Springs contributing to baseflow include the Gunnison Homestead Spring, less than one mile west of the proposed additional lease area, and Jewkes Springs one mile west of the permit area, near the north west corner. Discharges from these springs vary between 3 to 136 gpm and 1.1 to 38 gpm respectively.

The USGS maintains a gauging station (09312700) several miles northeast of the permit area, near the mouth of Beaver Creek, with a period of record from 1960 through 1989. The minimum annual discharge for this period was 338 acre-ft in 1961. The maximum annual discharge of 1,610 acre-ft occurred in 1973. The average annual discharge for the 29-year period of record was 3,310 acre-ft. Decreases in downstream flow are observed in Beaver Creek between monitoring stations SS-7 and SS-8. The decrease is most prevalent during the low-flow season. The loss of water along this section may be due either to alluvium, fracture and fault systems, or unknown factors.

The main water source in the Gordon Creek drainage is the North Fork of Gordon Creek, which is a perennial stream. The North Fork of Gordon Creek flows alongside County Road 290 southeast of the permit area. The total drainage is about 12,000 acres. Other principal drainages include Jewkes Creek (a perennial stream), Bryner Canyon, Consumers Canyon, Sweets Canyon and Coal Creek.

The State Division of Water Quality classifies Gordon Creek as Class 3C and Class 4 waters. These classifications are designated as non-game and aquatic life, and agricultural uses, respectively. Beaver Creek, located over the future proposed mine workings, is classified as 1C and 3A, designated as domestic and agricultural uses respectively. There are fisheries down stream of the proposed disturbed area in the North Fork Gordon Creek.

Surface-water Quantity

Streams within the CIA receive their maximum flows in late spring and early summer as a result of snowmelt runoff. Flows decrease significantly during the autumn and winter months. According to information presented in the 1989 CHIA 50% to 70% of the runoff occurs during May and July snowmelt. Summer thunderstorms may cause localized occurrences of short duration high intensity runoff.

Beaver Creek has a drainage area of approximately 16,700 acres, an average annual precipitation of 23 inches, and an average annual streamflow of 2,860 acre-ft (Waddell, et al.
1986). Beaver Creek is a perennial stream with base flow maintained by seeps and springs, such as the Gunnison Homestead Spring (2-6-W), and Jewkes Spring (SP-9), shown on Figure 6. Discharges from these springs vary between 3 to 136 gpm. Jewkes Spring was observed to have dry periods. Beaver ponds used to be more common in Beaver Creek and played a part in providing perennial flows. Most of them have been removed, which has left the stream channeled, resulting in less bank storage.

Decreases in downstream flow were observed in Beaver Creek between monitoring stations SS-7 and SS-8, monitored by Horizon Coal Mining Co. The decrease is most prevalent during the low flow season. This losing stream section may occur due to alluvium, fracture and fault systems; previous mining activities; or other, unknown factors. Flows monitored by the Beaver Creek Coal Company at stations 2-4-W and 2-3-W showed an average loss in flows from the upstream and downstream station. Flow ratios varied between 68% to 91% with an average of 80%. The mean flow for the upper station in 1988 was 176 gpm, and while the mean flow at the lower station was 221 gpm. A study of flows determining existing losing and gaining reaches was conducted in September of 1996 by Horizon.

The North Fork of Gordon Creek begins in Sweets Canyon. It is perennial and receives its flow from springs, which potentially intersect ground water from the Star Point Sandstone. The total drainage is about 12,000 acres. There is no flow data available for the North Fork of Gordon Creek below all mine operations. However, Beaver Creek Coal Company had established a stream sampling station below the Gordon Creek #2, #7 and #8 Mines in the North Fork of Gordon Creek. Observations from monthly flows data in 1988 ranged from 87 gpm to 359 gpm with a mean flow rate of 190 gpm.

Jewkes Creek flows down Consumers Canyon and drains a watershed slightly greater than 1 square mile. It discharges into the North Fork of Gordon Creek. Jewkes Creek is perennial due to flow from a developed spring (SP-1) on the left fork. Flow in Jewkes Creek has varied from about 200 gpm to 5 gpm. The flow data indicate that normally the creek flows all year at Horizon’s monitoring Station #5, but becomes intermittent at Station #3, a few miles below the mine, where it infiltrates into the alluvium and does not reappear immediately. Water may reappear where the Mancos shale outcrops. Diminished flows are caused by infiltration of the flow and a reduction of recharge flow. Bryner Canyon’s drainage basin is about one square mile. Bryner is an intermittent stream with flow usually occurring with rainstorms and spring runoff as a result of snowmelt periods. Flows up to 3.6 cfs have been measured. Intermittent springs and seeps were found in the drainage. The main spring discharges from below the Castle Gate A Coal Seam, above the Gordon Creek #2 mine pad. Flow was estimated to vary from 1 to 5 gpm. Flows which have accumulated in the channel seldom continued beyond the Gordon Creek #2, #7 and #8 Mines disturbed area. The general opinion is that this water has been infiltrating into old mine workings associated with the Swisher Mine.

The Coal Canyon drainage area is approximately 1,329 acres and is ephemeral in nature. One flow measurement was obtained in Coal Canyon above the Gordon Creek #3 and #6 Mines during spring runoff: flow was approximately 1.6 gpm. However, since reclamation, UDOGM personnel have observed greater flows in the channel during onsite inspections. Springs at the tributary of Coal Canyon contribute significant flow to the North Fork of Gordon Creek.
The Beaver Creek Drainage and Gordon Creek drainage have numerous springs which contribute to base flow of streams. All of the drainage and many of the springs provide a point of use for water rights. Water rights are used for stockwatering and irrigation.

**Surface-water Quality**

Regional studies by the USGS and others indicate that, the general chemical quality of surface water is relatively good in the headwaters of Gordon Creek. TDS are usually less than 500 mg/L and the water signature is a calcium-bicarbonate type. Near the confluence of Gordon Creek and the Price River the water signature changes to a magnesium-sodium-calcium-sulfate type water with dissolved solids content as high as 1100 mg/L (Mundorff, 1972). These changes in water quality are caused by water contact with Mancos shale and irrigation return flows. The Gordon Creek mines and Horizon Mine established water-monitoring plans to assess changes in water quality leaving the permit areas.

Mean TDS at the upper Gordon Creek #2, #7 and #8 monitoring station 2-4-W (1980 – 2001) was 286 mg/L. The lower station, 2-3-W, had a mean TDS of 313 mg/L over the same period. Values at these stations were generally less than 500 mg/L, although a 1,900 mg/L spike was reported in September 1996 at 2-3-W. The mean TDS for Bryner Creek at station 2-2-W was 441 mg/L and ranged from 150 to 4,000 mg/L. Data from early mining operations are not extensive. Because mining had already occurred in the CHIA prior to enactment of SMCRA, the pre-mining characteristics are not available.

TDS concentration of Beaver Creek varies from about 200 to 350 mg/L and is lower than Jewkes Creek, which typically ranges from 300 to 500 mg/L. The pH of Beaver Creek is typically 7.5 to 8.5 and Jewkes Creek generally varies from 8.0 to 8.6. Both Jewkes Creek and Beaver Creek are typically a calcium bicarbonate type water. Dissolved constituents tend to be inversely proportional to flow while total constituent concentrations tend to be directly proportional to flow. The ranges of water quality observed from 1992 through 2004 for the Horizon Coal Company are presented in Table 5.

**TABLE 5**

**SURFACE-WATER QUALITY**

Horizon Mine Data Summary

<table>
<thead>
<tr>
<th>Station</th>
<th>Period Sampled</th>
<th>Total Fe mg/L</th>
<th>Total Mn mg/L</th>
<th>TDS mg/L</th>
<th>TSS mg/L</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-3</td>
<td>Jewkes Creek</td>
<td>ND - 51</td>
<td>ND - 1.9</td>
<td>55 - 1,446</td>
<td>ND - 5,900</td>
<td>6.2 - 9.2</td>
</tr>
<tr>
<td>SS-5</td>
<td>Jewkes Creek</td>
<td>ND - 15</td>
<td>ND - 0.51</td>
<td>313 - 606</td>
<td>7 - 929</td>
<td>7.8 - 8.2</td>
</tr>
<tr>
<td>SS-7</td>
<td>Jewkes Creek</td>
<td>ND - 5.2</td>
<td>ND - 0.20</td>
<td>182 - 360</td>
<td>ND - 306</td>
<td>5.1 - 8.8</td>
</tr>
<tr>
<td>SS-8</td>
<td>Beaver Creek</td>
<td>ND - 2.4</td>
<td>ND - 0.14</td>
<td>192 - 431</td>
<td>ND - 145</td>
<td>7.8 - 8.6</td>
</tr>
<tr>
<td>SS-10</td>
<td>Jump Creek</td>
<td>ND - 4.6</td>
<td>ND - 0.26</td>
<td>60 - 291</td>
<td>ND - 51</td>
<td>7.2 - 9.0</td>
</tr>
<tr>
<td>SS-11</td>
<td>Sand Gulch</td>
<td>0.3 - 3.4</td>
<td>ND - 0.39</td>
<td>108 - 388</td>
<td>ND - 96</td>
<td>7.0 – 8.6</td>
</tr>
</tbody>
</table>


Sediment Yield

The potential for increased suspended solids and sediment loading to Gordon Creek is probably highest during the construction phase of operation and reclamation. Hidden Splendor Resources has committed to monitor for turbidity of the water upstream and downstream of the site during the construction phases. A criteria for Class 3C allows a turbidity increase of 15 (NTU).

Increases in sediment during the operational period have been minimized through the use of disturbed and undisturbed area drainage controls. Undisturbed drainage is diverted away from the disturbed areas of the mines, while disturbed drainage controls such as ditches, berms, and culverts control and direct runoff and sediment to sedimentation ponds.

Runoff and sediment controls have been constructed at the Gordon Creek #3 and #6 Mines, Gordon Creek #2, #7 and #8 Mines and Horizon Mine. The ponds are still in place at the Gordon Creek Mines. The Horizon Mine’s sedimentation pond is located in Consumers Canyon. Hidden Splendor Resources has committed to store snow in sites that will directly drain to the sedimentation pond. During the reclamation period, a combination of alternate sediment control measures and sedimentation ponds will be used.

During the late 1990s, logging was done in the Beaver Creek area on Stamatakis property. Logging and transport activities disturbed substantial areas along the roads and riparian areas of Beaver Creek, the North Fork of Gordon Creek and Jewkes Creek. Trees were removed from the property and transported out over the county road that connects to State road 139, the North Fork of Gordon Creek. There were no Best Management Practices used for sediment control on this logging site. Sediment yield from the logging sites and roads has been substantial. During the summer of 1997 the team conducting a subsidence evaluation noticed areas had been logged down to the Beaver Creek without a protection barrier. Sediments from the logging sites and access road flowed directly into the creek. Trees and branches littered the side of the creek. The dirt road along Beaver Creek was ground to a fine powder, in some places as much as 1 foot deep. The point bars and bottom of Beaver were covered with silt.

Logging continued during the winter months. As roads became muddy, the logging company used graders and bulldozers to excavate the muddy layers, which were pushed in mounds above the roads and creeks where they could easily flush into Beaver Creek and Jewkes Creek. The total effects from logging have not been quantified, however sediment loading was very noticeable and likely effected the invertebrate population.

Spills

The operator of the Horizon Mine, Hidden Splendor Resources, Inc., indicates diesel fuel, oils, greases and hydrocarbon products will be stored above ground and may be spilled in the mine and on the surface during mining operations. The operator proposes the berm surrounding the tank will be adequate to contain the total volume of the tank, in the event water needs to be drained from the berm. Spills will be handled in accordance with the Spill Prevention, Control, and Countermeasure (SPCC) Plan in Appendix 7-10 of the Horizon MRP.
The operator can provide additional reasonable operation measures to minimize hydrologic impacts on and off the permit area.

Recharge

Recharge to springs and seeps in the CIA originates in the small drainage or basin in the immediate vicinity. The low hydraulic conductivity of the rocks limits recharge, although fractures are locally important in recharge and ground-water flow. Waddell (1986) showed that springs in the upper reaches of Beaver Creek, in the Castlegate Sandstone and some members of the Blackhawk Formation, are very responsive to precipitation events. They usually have high, steep hydrographs responding to rapid recharge. Springs that are associated with regional aquifers or faults often have longer less fluctuating hydrographs. Low precipitation and high evapotranspiration limit the amount of water available for recharge.

Recharge can occur where permeable strata outcrop and are exposed to direct precipitation and near-surface infiltration. Recharge percolates from the surface downward until shale is encountered and then moves downdip following discontinuous, but more permeable sandstones. Water either continues to move downdip until it is discharged at the surface or resumes vertical flow where more permeable zones are encountered, and recharge eventually reaches the deepest aquifer. Vertical ground-water movement through the overlying sediments is minimal due to the low permeability of the overlying units and the presence of relatively impermeable shales. Steep slopes and relatively small outcrop exposure areas are two factors that limit recharge. Faults and fractures are important ground-water conduits in the CHIA.

Recharge to the Blackhawk Formation and Star Point Sandstone aquifer can occur where formations are exposed and come in direct contact with surface runoff or the alluvial systems, such as in sections of Beaver Creek. Recharge to ground water is limited by formation permeabilities.

Perched Ground-water System

Perched aquifers in the Wasatch Plateau and Book Cliffs typically occur in numerous small, localized lithologic units that have sufficient permeability to store and transmit ground water. They are found at shallow depths in the Flagstaff, North Horn, and Price River Formations and upper portions of the Blackhawk Formation. The Blackhawk Formation contains small, perched aquifers that are dominantly interbedded sequences of shale, siltstone, and fluvial channel sandstones. In some larger sandstone units of the Blackhawk Formation fine grained, cemented sandstones are typically the water-bearing units with lower permeability siltstones and relatively impermeable shales acting to confine ground-water movement. Burned-out coal zones also have good permeability and can be perched aquifers. Isolated perched water tables may occur deeper in the rock where more permeable zones are encountered.

Perched aquifers are of limited areal extent and thickness because of the discontinuous or lenticular shape of the sandstone bodies. Variations of permeability within the sandstone bodies further limit storage and movement of water, and perched aquifers can be breached and truncated by deeply eroded surface drainage. The discontinuous character of the sandstones and the abundance of clay throughout the formations favor formation of local flow systems that discharge through numerous small seeps and springs.
Discharge from perched aquifers is primarily from seeps and springs at outcrops of sandstone-shale interfaces. Discharge from the perched ground-water systems to deeper strata can also occur due to fracture or fault related secondary permeability: such vertical movement is significant in the CIA because of the abundance of faulting and fracturing.

Perched aquifers are generally recharged within small areas in the immediate vicinity of the seeps and springs where they discharge. Recharge is almost exclusively by infiltration of direct precipitation and snowmelt, and discharge from these aquifers closely tracks precipitation rates. The combination of steep terrain and relatively low permeabilities probably limit infiltration to less than 5 percent of annual precipitation (Price and Arnow, 1979).

**Regional Aquifer System**

The term *regional aquifer* is commonly used in the Book Cliffs and Wasatch Plateau Coal Fields to describe the saturated portions of the Blackhawk Formation and Star Point Sandstone [and sometimes other strata]. In such usage, regional aquifer usually refers to any ground water irrespective of quality, quantity, use, storage, flow and transport, and discharge. However, ground-water storage and movement in these areas is typically of a local or intermediate nature and the Division feels that, generally, there is little or no basis for describing these as regional systems.

There is ground water in these deeper, consolidated strata, and they may have characteristics of an aquifer at least over a limited area. Lithologic variability within these rocks influences the amount and direction of ground-water flow. Because the consolidated strata in the Blackhawk Formation and Star Point Sandstone mostly have poor hydraulic conductivity, fractures and faults are important paths for ground-water transport. Faults may act as either conduits or barriers to ground-water movement. There is extensive faulting in the CIA: planned underground operations of the Horizon Mine are almost exclusively within the Fish Creek graben. Because the Blackhawk Formation includes the primary coal-bearing sequence, ground water in this formation can be directly affected by the mining operations.

Water is unable to flow downward through the Mancos in any significant amount but will flow laterally through more permeable overlying strata until it discharges at the surface. Springs discharge along the Blackhawk-Mancos contact in Coal Canyon and Bryner Canyon. Leakage to the Mancos and other underlying units is minimal.

**Stored Mine Water System**

Coal mining during the past 70 years has resulted in extensive underground mine workings in the CIA. The mine workings follow the attitude of the coal and stratigraphy. As the mine moves deeper into the mountain it can extend into the local ground-water table: this appears to be the situation with the current Horizon Mine. A mine can also come in contact with new facies where water is stored or fractures are connected with the perched ground-water system. The Gordon Creek #3 Mine encountered a fault that produced substantial amounts of water until it was drained.
Abandoned mine workings that extend into the saturated strataserve as sinks. However, seepage into the mines is extremely slow. In the western coal reserves area, mine inflows appear to be greatest where extensive retreat mining has produced substantial subsidence.

The total volume of ground water stored in the old mine workings in the eastern coal reserves is unknown, although it is probably substantial. There are few known instances of mine-water discharge from old workings to the surface, but most of the abandoned mine workings in the area have been sealed and water accumulates predominantly in down-dip workings behind the seals. Ground-water inflow to the old mine workings will continue until equilibrium is established between inflow, discharge to the surface, recharge into the subsurface, and the local ground-water table.

Ground-water Usage

Only the alluvial-colluvial aquifer yields sufficient water to serve as a reliable source of water for beneficial use in the CIA. In certain areas the perched ground-water and stored underground mine water systems provide water of sufficient quantity and quality for specific uses such as stock watering. A number of individuals, water user associations, government agencies, and corporate entities hold ground-water rights for alluvial-colluvial wells in area drainages, shallow wells that intercept perched aquifers, and numerous small springs and seeps. Water rights have been filed on mine inflow or stored mine water in four mines in the area.

Actual ground water use within the hydrologic basin is primarily limited to large volume municipal and irrigation use or small volume stock watering applications. The Price River Water Improvement District extracts water for municipal use from ground-water wells located several miles northeast of the CIA, in Sections 23 and 24 of T. 12 S., R. 10 E. Along the Price River valley, especially near Heiner, Martin, and Helper, numerous individuals and corporations have significant water rights that are used for irrigation. Additionally, PacifiCorp owns significant water rights for water from their UGW well located in Section 35 of T. 12 S., R. 9 E.
V. MATERIAL DAMAGE CRITERIA - RELEVANT STANDARDS AGAINST WHICH PREDICTED IMPACTS CAN BE COMPARED.

Standards of quality for waters of the State of Utah are set by the Utah Department of Environmental Quality and the state Division of Water Quality, R317 (Utah Administrative Code). There are also primary (PDW) and secondary (SDW) drinking water standards set by the Division of Drinking Water in Rules for Public Drinking Water Systems, R309 (Utah Administrative Code). The drinking water standards are generally more stringent than the water quality standards when a parameter is listed in both, but many parameters are unique to one set of standards or the other. Standards from both sets of rules were established for Total Dissolved Solids (TDS), total iron, total manganese, and pH. There is a water quality standard for total manganese as it relates to Post-Mining Areas, underground mine drainage after application of best practicable control technology currently available (40CFR Ch.1 Subpart 434.55). There is no drinking water or water quality standard for Total Suspended Solids (TSS).

The level of protection or non-degradation for waters is also determined by the Utah Division of Water Quality. Standards usually vary between classifications. Waters within and adjacent to the permit area are classified as:

1C Protected for domestic use with prior treatment
2B Protected for secondary contact recreation
3A Protected for cold-water species of game fish and other cold-water aquatic life
3C Protected for non-game fish and other aquatic life
4 Protected for agricultural uses

Beaver Creek and its tributaries are classified for 1C, 2B, 3A, and 4 water uses. The Gordon Creek drainage and its tributaries are classified for 2B, 3C, and 4. Identified land uses within the proposed Horizon Mine are wildlife and livestock grazing, recreation, and logging. Areas are not being evaluated for wilderness potential within the CIA. The CIA includes a section of the DNR Wildlife Management Area. Recreational use involves four-wheel driving, camping, and hunting.

The most likely post mining land uses in the CIA for the foreseeable future will continue to be logging, livestock and wildlife grazing, and recreation. The land and waters of the CIA should be maintained or restored to support these uses.
VI. ESTIMATE OF PROBABLE FUTURE IMPACTS OF MINING ON THE HYDROLOGIC RESOURCES

R729.100 requires the Division to provide an assessment of the probable cumulative hydrologic impacts of the proposed coal mining and reclamation operation and all anticipated coal mining and reclamation operations upon surface- and ground-water systems in the CIA. This CHIA must be sufficient to determine whether the proposed coal mining and reclamation operation has been designed to prevent material damage to the hydrologic balance outside the permit area. The assessment will include consideration for those measures used to minimize impacts in mining operations and will be assessed for risk analysis based on past mining experiences and site-specific information.

Additionally, R728 requires each mine in the CIA to provide a PHC Determination of the following:

- Whether adverse impacts may occur to the hydrologic balance;
- Whether acid and toxic forming materials exist which could result in contamination of surface or ground-water supplies;
- What impacts coal mining and reclamation activities will have on; sediment yield; acidity, total suspended solids, dissolved solids and other important water quality parameters; flooding or streamflow alteration; ground-water and surface-water availability; other characteristics required by the Division;
- Whether the proposed surface mining and reclamation activity will result in contamination diminution or interruption of an underground or surface source of water in the permit or adjacent area.

Adverse Impacts to the Hydrologic Balance

The hydrologic balance is defined under the regulatory requirements R645-100: "Hydrologic Balance" means the relationship between the quality and quantity of water inflow to, water outflow from and water storage in a hydrologic unit such as a drainage basin, aquifer, soil zone, lake, or reservoir. It encompasses the dynamic relationships among precipitation, runoff, evaporation, and changes in ground and surface-water storage.

Potential Changes in Ground-water Quantity

Potential changes in ground-water quantity can result from mining. Table 6 presents a risk assessment of the potential mining related impacts to the hydrologic system. Risk is rated as High (H), Moderate (M), and Low (L). Potential changes and site specific information on the hydrologic system is also discussed.
### TABLE 6
GROUND-WATER QUANTITY POTENTIAL IMPACTS

<table>
<thead>
<tr>
<th>Source</th>
<th>Potential Change in Hydrologic Regime</th>
<th>Mining related factor</th>
<th>Mining related operations used to minimize impacts or, site-specific characteristics affecting the potential for impact.</th>
<th>Evidence of existing and past water quantity changes that may be attributed to mining.</th>
<th>Risk that a mining related factor might occur.</th>
<th>Risk to quantity of a water use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Springs</td>
<td>Dewatered</td>
<td>Subsidence induced fractures propagating through perched aquifers associated with springs.</td>
<td>Most surface springs issue from the upper geologic units of the Blackhawk. Massive Sandstone units exist above the coal to be mined diminishing potential for surface expression. Numerous surface springs are present above previously mined areas.</td>
<td>No diminished flows have been documented by previous mining activities.</td>
<td>M-L</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dewatering fractures associated with springs.</td>
<td>Operations are designed to avoid the major fault system. Numerous smaller fault and fractures are present. A fracture associated with HZ-91-1 will be mined through. No springs were identified as associated with this fault.</td>
<td>Mining through a graben in Gordon Creek #3 and #6 resulted in 400 gpm inflow but no decrease in discharge was documented for any springs.</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Change in direction of Piezometric surface dewatering springs</td>
<td>A limited number of springs issue from aquifers below the coal. Geologic structure, dip, location and orientation could result in interruption of springs issuing below the mine but they should re-issue following reclamation.</td>
<td>Excess water encountered from mining has not been discharged from portals in previous mined areas. An estimated excess of 50 gpm was predicted may off set flow losses if they occur.</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Increased Discharge</td>
<td>Sumping or redirecting in-mine water could result in increased recharge to springs within and below the mined sections.</td>
<td>Dewatering of aquifers above the coal may increase recharge to aquifers below mined areas. Interbedded shales may limit vertical movement.</td>
<td>Vegetative changes may be the result of increased flows from Springs in Coal Canyon and may be mining related.</td>
<td></td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>Change in location of discharge</td>
<td>Sumping or redirecting in-mine water could result in a change in location of springs</td>
<td>Location of sumps in mine, dip of coal beds and location of fractures in the system may have an affect on where springs are relocated.</td>
<td>New springs issuing from the canyon west of Coal Canyon may be mining induced.</td>
<td></td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>Subsidence could cause surface springs to relocate.</td>
<td>Subsidence is not expected to reach the surface.</td>
<td>No known subsidence has changed the location of springs in this area.</td>
<td></td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>
### TABLE 6
GROUND-WATER QUANTITY POTENTIAL IMPACTS (cont.)

<table>
<thead>
<tr>
<th>Source</th>
<th>Potential Change in Hydrologic Regime</th>
<th>Mining related factor.</th>
<th>Mining related operations used to minimize impacts or, site-specific characteristics affecting potential for impact.</th>
<th>Evidence of existing and past water quantity changes that may be attributed to mining.</th>
<th>Risk that a mining related factor might occur.</th>
<th>Risk to quantity of a water use.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquifers Above Coal</td>
<td>Increased Recharge</td>
<td>Increased recharge may occur due to subsidence above the coal seam.</td>
<td>Increased recharge to aquifers above the coal is unlikely unless fractures heal between aquifers. Clays have been considered to have sealing characteristics between water bearing zones. Overburden between the coal and most surface water is greater than 800 ft.</td>
<td>The old Sweet s mine may have subsidence fractures near the surface in areas where overburden is shallow. Drill holes indicate zones above mined areas are dry.</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>Increased discharge or, dewatering.</td>
<td>Increases in hydraulic conductivity from caving and fracturing above the mined zone.</td>
<td>Few aquifers have been identified above the coal that are known to issue as a spring or associated with a water right.</td>
<td>Most in- mine waters were stated to come from isolated channel sandstone.</td>
<td>H</td>
<td>M</td>
</tr>
<tr>
<td>Aquifers Below Coal</td>
<td>Increased recharge and discharge rates.</td>
<td>Increases in recharge may occur due to location of sumps and due to dewatering aquifers above the mine, or, increasing hydraulic conductivity between overlying aquifers. New discharge locations may occur.</td>
<td>Mine operations including location of sumps, and mine water discharge rates may affect the rate of recharge to aquifers below the coal. Following reclamation increased recharge may occur from intercepting aquifer waters above the coal. The aquifers below the coal are separated by clay and shale layers that may impede flow to lower aquifers.</td>
<td>An increase in discharge may have occurred in the Storrs Sandstone of the Star Point aquifer. New seeps are present in a canyon west of Coal Canyon below the mined zone.</td>
<td>H</td>
<td>L-M</td>
</tr>
<tr>
<td>Mined Coal Zone</td>
<td>Change in Hydraulic Conductivity.</td>
<td>Due to the removal of coal and subsidence above the coal the hydraulic conductivity will be changed.</td>
<td>The amount of coal removed will dictate total influence.</td>
<td>No related information has been presented from previous mining in the CIA.</td>
<td>H</td>
<td>M</td>
</tr>
</tbody>
</table>

**Evaporative Losses**

Presently the mines at Gordon Creek #2, #7 and #8, are under reclamation and all mine associated openings are presently sealed. The proposed mine ventilation in the Horizon Mine is expected to evaporate an average of 6 gpm (10 acre-ft/year) from air circulating through the mine.

**Mine Water Discharge**
Mine water was produced and has been discharged from the Gordon Creek #3 Mine and most recently the Horizon Mine. The Gordon Creek #2, #7 and #8 Mines did not produce enough mine water to be discharged.

The portals of the Beaver Creek Coal Company Gordon Creek #3 Mine were located in Coal Canyon, and initial mine development was within the Fish Creek Graben (Figure 3; Figure 6-2 of the Horizon MRP). Mining proceeded to the south and west until stopped by a 40-ft fault at the edge of the Fish Creek Graben. Mining to the north, the working crossed the fault zone at the northeast side of the graben, where offsets were on the order of 12 to 14 ft. The mine had been dry before reaching this faulted area, but then water began to flow through the mine floor at approximately 400 gpm as the workings were advanced: during retreat mining this area was dry. The fault intersects the creek in Coal Canyon at about 7400 ft level.

The original intent was to avoid this fault in the Horizon No. 1 Mine. Soon after mining began, it became evident that more water was entering the mine than was expected from dewatering of the Blackhawk Formation. It was concluded that the old workings had intercepted a fault, not the bounding fault of the graben but probably one tied into it somewhere near where the Gordon Creek #3 mine crossed out of the graben and encountered similar inflow. This fault was conveying a large volume of water into the mine. As the Horizon No. 1 North Mains and adjacent panels were advanced in 2000 – 2002, they encountered the same water-bearing fault. It initially produced 450 gpm, but inflow dropped to 200 to 300 gpm within two months. When mining ceased in 2002, water continued to be pumped from the mine at 294 gpm, and in 2003 this dropped to 269. When mining resumed in August 2003, an estimated 30 gpm flowed from the working face, so the pumping volume increased. Approximately 100 ft back from the face the entries do not produce water.

Mine water is currently being discharged from the Horizon No. 1 Mine. The rate of discharge has been fairly constant at 350 gpm since May 2003 (Chart 1). The mine has reached a level that Hidden Splendor Resources thinks matches the hydrostatic head in the upper member of the Star Point Sandstone.

Plans for the Horizon No. 1 Mine project the water-bearing fault will be encountered in the future. The expected maximum inflow from the fault when it is breached is on the order of 400 to 500 gpm. Combined with inflow from dewatering the surrounding strata, estimated using Lines (1985) method, the maximum inflow would be approximately 500 to 600 gpm for a short period of time but average more like 200 to 300 gpm.

When mine water is discharged from the Gordon Creek #3 Mine and Horizon No. 1 Mine, it is discharged to the sedimentation ponds until water quality tests show it meets the standards to discharge it into the stream under a UPDES permit.

Based on a review of mine records, Roger Skaggs (a principal in the Blue Blaze Coal Company and an employee of the Beaver Creek Coal Company, personal communication to Hidden Splendor Resources, Inc. and cited in the Horizon Mine MRP) is of the opinion that many faults have been mined through in the Hiawatha seam in the mines adjacent to the Horizon No. 1 Mine with only insignificant or minor amounts of water encountered,
Chart 1 – Discharge from the Horizon No. 1 Mine

There is insufficient information from early mining operations to determine the pre-mining elevations of the potentiometric surfaces for aquifers within, above, and below the coal seams. Mining activity has occurred in the Castle Gate A and Hiawatha Seams, which may have dewatered previously existing aquifers. No monitoring well data exist from these previous mining activities. Exploratory holes LMC-1, LMC-3, and LMC-4, drilled within the permit boundary in the late 1976 and 1980, were retained as open holes to measure water levels, but they were plugged-back to elevations above well above the coal seams. They were reported dry at total depth in the coal seams at the time they were drilled and dry at all subsequent measurements at the plugged-back depths.

Exploration drill holes BC-1 and BC-2 are located very near the Beaver Creek channel, just north of the permit area. Beaver Creek Coal Company drilled them in the late 1970s. Both have artesian flow. BC-1 was spudded in the top of the Blackhawk Formation and BC-2 was spudded approximately 60 to 80 ft above the Castlegate - Blackhawk contact. These wells are assumed to produce water from approximately 80 to 100 ft below ground surface, suggesting that water is contained in some of the upper sandstone units of the Blackhawk Formation, although faults may be the source of this water.

In October 1995, Horizon Coal Company completed four additional monitoring wells. HZ-95-1-S was completed in a saturated zone in the Blackhawk Formation but above the coals, at 205 to 210 foot depth. HZ-95-1, HZ-95-2, and HZ-95-3 were completed in the Spring Canyon Sandstone. A fifth piezometer, HZ-01-06-1, was completed in November 2001 near the northern
boundary of the Horizon Mine permit area; it was also completed in the Spring Canyon Sandstone. HZ-95-1 will be intercepted by the planned mining, and HZ-95-3 and HZ-01-06-1 may be impacted by subsidence. HZ-95-2 is outside the Fish Creek Graben and outside the proposed mining area.

Water levels in these piezometers have been measured during the first, second, third, and fourth quarters, the sites usually being inaccessible November through February (Chart 2). Results are tabulated in Table 7-1 in the Annual Reports and in the Division’s database. Figures 7-2, -2A, and -2B of the Horizon MRP represent the potentiometric surface as it was in December 1995, September 1996, and June 2002.

### Table 7 – Information on Piezometers in the CIA

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
<th>Date</th>
<th>Surface (Top of Casing)</th>
<th>Depth</th>
<th>Screened Interval</th>
<th>Stratum</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC-1</td>
<td>T. 13 S, R. 8 E, SWSE Sec 5</td>
<td>1970s</td>
<td>80-100</td>
<td>?</td>
<td></td>
<td>Upper Blackhawk</td>
</tr>
<tr>
<td>BC-1</td>
<td>T. 13 S, R. 8 E, NWNW Sec 4</td>
<td>1970s</td>
<td>80-100</td>
<td>?</td>
<td></td>
<td>Upper Blackhawk</td>
</tr>
<tr>
<td>HZ-95-1S</td>
<td>T. 13 S, R. 8 E, NWSW8 Sec 8</td>
<td>October 1995</td>
<td>8352.6 (8356.5)</td>
<td>220</td>
<td>205-215</td>
<td>Blackhawk</td>
</tr>
<tr>
<td>HZ-95-1</td>
<td>T. 13 S, R. 8 E, NWSW8 Sec 8</td>
<td>October 1995</td>
<td>8352.6 (8356.7)</td>
<td>1080</td>
<td>1065-1075</td>
<td>Spring Canyon Member</td>
</tr>
<tr>
<td>HX-91-2</td>
<td>T. 13 S, R. 8 E, NWSW8 Sec 8</td>
<td>October 1995</td>
<td>8346.3 (8347.6)</td>
<td>1200</td>
<td>1185-1195</td>
<td>Spring Canyon Member</td>
</tr>
<tr>
<td>HZ-93-3</td>
<td>T. 13 S, R. 8 E, NWSW8 Sec 8</td>
<td>October 1995</td>
<td>7897.6 (7901.5)</td>
<td>470</td>
<td>455-465</td>
<td>Spring Canyon Member</td>
</tr>
<tr>
<td>HZ-01-06-1</td>
<td>T. 13 S, R. 8 E, NWSW8 Sec 8</td>
<td>November 2001</td>
<td>(8761.4)</td>
<td>Bottom 60 ft</td>
<td></td>
<td>Spring Canyon Member</td>
</tr>
</tbody>
</table>

HZ-95-1 was sampled for water quality eight days prior to the December 1995 water-level measurement. In an attempt to purge the well and obtain a representative water sample, the well had been pumped periodically over a period of approximately 3 weeks. The well pumped dry after only 1 to 10 gallons of water were removed, and recovery took several days, recharging very slowly. This pumping and recovery cycle was repeated several times. Water levels perhaps had not fully recovered from pumping when the water level was measured in December 1995.

The December 1995 water-level data show that the Spring Canyon Tongue had a hydraulic gradient of 0.014 in an east-southeast direction (Figure 7-2 of the Horizon MRP). The
overlay of the potentiometric surface and elevation of the Spring Canyon Tongue was used by Horizon to estimate the saturated portion of the coal formation. Data obtained in July through September 1996 indicate the surface-water elevation had remained relatively steady in Well HZ-95-2, but water elevations decreased by approximately five ft at well HZ-95-3 and increased by seventeen ft at HZ-95-1. The September 1996 data indicate that the potentiometric surface had a gradient of 0.019 ft/ft and the general direction of flow was a little more southerly than the December 1995 data indicated (Figure 7-2a of the Horizon MRP). The November 2002 map (Figure 7-2b of the Horizon MRP) indicates further shift of the gradient towards the south, with large drops in water levels in the three older piezometers. This probably results from dewatering of the Star Point Sandstone by the mine.

The potentiometric surface at HZ-01-06-1 dropped 85 ft between the first and second readings. It is unclear whether the drop was due to the mine de-watering the aquifer or if the initial reading was inaccurate: during drilling, circulation was lost numerous times resulting in drilling fluid flowing into the formation, and drilling fluid reentering the bore hole may have artificially elevated the potentiometric surface for the first reading. However, HZ-95-1 experienced a 104-ft drop over a similar time period between the fall of 1999 and spring of 2000. Due to this relatively rapid drop in the potentiometric surface and the magnitude of the drop at HZ-95-1 it can be concluded that the influence of water-bearing fault extends at least as far north as Beaver Creek, where HX-95-1 is located. If the initial water level reading for HZ-01-06-1 is valid then it can be concluded that the influence of the water-bearing fault on the potentiometric surface extends at least to the northern permit boundary.

Chart 2 – Water Levels Measured in the HZ Series Piezometers
Most springs in the CIA issue above the mapped and projected potentiometric surface of the Star Point. This indicates that fractures typically do not connect the Star Point Sandstone with these shallow systems. Due to low hydraulic conductivity of the lower formations, water is retained and discharged in shallow systems, at times through springs associated with near-surface fractures.

Horizon piezometers HZ-95-1, HZ-95-2, HZ-95-3, and HZ-01-06-1 were completed in only the top member of the Star Point Sandstone. The Star Point intertongues with and sits over shale members, effectively blocking vertical flow below the sandstones. However, water has issued from fractures in strata below the top of the Star Point.

Inter-mingling of Aquifer Waters

Intermingling of aquifer waters could occur if subsidence-induced fracturing were to increase localized porosity across aquifers. Subsidence might occur where full extraction mining is planned. In most areas, the overburden is greater than 600 ft, sufficient to minimize fracturing on the surface. Subsidence impacts are not as catastrophic with room and pillar mining (planned by Horizon Mine) as seen when using longwall equipment.

Surface-water Quantity

Surface-water quantity may be affected by changes to the ground-water system. The interaction of these systems and the geologic system may influence quantity of surface-water flows. Table 8 presents a risk assessment of the potential for a mining related factor to affect the hydrologic system and the potential that a quantity of use may be affected by these changes. Risk is rated as High (H), Moderate (M), and Low (L). Additional potential changes or site-specific information on the hydrologic system is also discussed below.

**TABLE 8**

<table>
<thead>
<tr>
<th>Stream</th>
<th>Potential Change in Hydrologic Regime</th>
<th>Mining related factor.</th>
<th>Mining related operations used to minimize impacts, or site-specific characteristics affecting potential for impact.</th>
<th>Evidence of existing mining characteristic</th>
<th>Risk that a mining related factor might occur.</th>
<th>Risk to quantity of a water use.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jewkes Creek</td>
<td>Subsidence induced fractures propagating to the surface.</td>
<td>The mine operations are set up to avoid mining under this stream. And a stream buffer zone has been designated.</td>
<td>This stream has not been mined under in the past.</td>
<td>H</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>Jewkes Creek</td>
<td>Loss of stream flow</td>
<td>Interception of water from fractures and aquifers that deplete baseflows.</td>
<td>Mine operations were set up to avoid mining into the fracture associated with this stream. Much of the water originates from springs outside the area proposed to be mined.</td>
<td>No changes in streamflow have been noted on Jewkes Creek related to mining the area.</td>
<td>M-L</td>
<td>L</td>
</tr>
</tbody>
</table>
## PROBABLE FUTURE IMPACTS

### Upper Gordon Creek

<table>
<thead>
<tr>
<th>Stream</th>
<th>Potential Change in Hydrologic Regime</th>
<th>Mining related factor.</th>
<th>Mining related operations used to minimize impacts, or site-specific characteristics affecting potential for impact.</th>
<th>Evidence of existing mining characteristic</th>
<th>Risk that a mining related factor might occur.</th>
<th>Risk to quantity of a water use.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increases in streamflow.</td>
<td>Increases in streamflow could occur from mine water discharges, increased hydraulic conductivity between aquifers above the coal and, transbasin diversions.</td>
<td>Mine operations can be set up to control discharge rates. Significant aquifers directly above the coal seam have not been identified.</td>
<td>No changes in streamflow have been documented on Jewkes Creek related to previously mining the area.</td>
<td>M</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Mine water discharge could potentially increase summer season baseflow. Following reclamation, increased conductivity may seasonally increase or decrease discharge based on retention time of the system.</td>
<td>Operations can control sumping locations and thereby control mine discharge rates during mining. Although discharging may be desirable. Clay swelling and settling of overburden over time may decrease the hydraulic conductivity of the system following mining.</td>
<td>Excess of in-mine water is predicted to be discharge at a rate of 50 gpm. Because most discharge from Jewkes creek is from springs not expected to be impacted, changes following reclamation are not expected.</td>
<td>H</td>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsidence induced fractures propagating to the surface.</td>
<td>With an overburden of approximately 1000 ft and a coal thickness of 7.5 ft there is little potential for subsidence cracks to propagate to the surface. Any fracturing that does occur in the stream channel is likely to fill rapidly as a result of sedimentation. With cover greater than 800 ft, panels oriented perpendicular to the stream, and full extraction of the coal, some short-term effects can be expected, but the stream is expected to revert to a pre-mining configuration.</td>
<td>Previous mining has occurred under Beaver Creek without documented losses.</td>
<td>H</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss of stream flow</td>
<td>In the event that a sharp subsidence induced drop occurs at the fault, with headcutting at upstream fault crossing, ponding and downcutting at downstream fault crossing, or loss of streamflow into fractures.</td>
<td>Reconstruct the impacted section of the channel to be erosionally stable so as to prevent erosion and loss of topsoil. If stream flow is lost into the fault, excavate and backfill the scarp fracture with clay prior to reconstructing the channel. If subsidence fractures occur without vertical displacement and flow is lost into the fracture, seal the fracture with a mixture of soil and bentonite.</td>
<td>Previous mining has occurred under Beaver Creek without documented movement along the graben faults.</td>
<td>M</td>
<td>L</td>
<td></td>
</tr>
</tbody>
</table>
## PROBABLE FUTURE IMPACTS

<table>
<thead>
<tr>
<th>Stream</th>
<th>Potential Change in Hydrologic Regime</th>
<th>Mining related operations used to minimize impacts, or site-specific characteristics affecting potential for impact.</th>
<th>Evidence of existing mining characteristic</th>
<th>Risk that a mining related factor might occur.</th>
<th>Risk to quantity of a water use.</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Fork Gordon Creek</td>
<td>Decreased Baseflow: Decreased base flow could occur if springs are dewatered or if streams in connection with fractures are dewatered during mining, or if subsidence propagates fractures to the surface increasing losses.</td>
<td>Massive sandstone units are believed to be important in reducing propagation of fractures to the surface. Clays are believed to swell shut and reduce flow potential in fractures. Where fractures may be dewatered, stream losses would be related to the rate of flow through the alluvium to the fracture.</td>
<td>Previous mining has occurred under Beaver Creek without documented losses in baseflow although this is a limited database.</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Trans Basin Diversions</td>
<td>Trans Basin Diversions: Could occur through intercepting surface waters and springs in Beaver Creek that are discharged into the Gordon Creek Basin.</td>
<td>Interception of springs and surface waters in the Beaver Creek drainage is not expected. Increased porosity and dewatering of fractures may increase vertical migration of water and result in losses from the Beaver Creek drainage to Gordon Creek.</td>
<td>No springs or surface waters have been documented to be intercepted through past mining practices, although the database is limited.</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>North Fork Gordon Creek</td>
<td>Decrease in Streamflow: Reduced flows from dewatering fractures and aquifers depleting surface flows.</td>
<td>Relative location downstream of mine operations may result in temporary losses during mining operations and should recharge following reclamation. Mine water discharge may result in no net change if mining intercepts these waters.</td>
<td>No noted decreases have been identified in past operations although database is limited.</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>North Fork Gordon Creek</td>
<td>Increase in Streamflow: Increases could occur from transbasin diversions. Dewatering perched aquifers and fractures.</td>
<td>The lower stream segment is below the base of the Hiawatha and may receive increased base flow if increased recharged occurs from mining activities.</td>
<td>Mine water discharge has not occurred in previous mining activities but is predicted to occur. Increased discharges from springs along Coal Canyon have been noted.</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>North Fork Gordon Creek</td>
<td>Seasonal Changes: Seasonal changes could occur due to increased hydraulic conductivity reducing residence time in the aquifers.</td>
<td>The equilibrium the system reaches following mining will determine whether seasonal changes may occur. Because the existing system is highly fractured, increased conductivity may not significantly affect seasonal flows.</td>
<td>Seasonal changes have not been noted from past mining although the database is limited.</td>
<td>M</td>
<td>L</td>
</tr>
</tbody>
</table>
PROBABLE FUTURE IMPACTS

Upper Gordon Creek

Presence of Acid- or Toxic-Forming Materials

Tests for Acid and Toxic forming materials were conducted on roof and floor samples in LMC-4 and HZ drill holes. Results of the chemical analyses in Table 6-5 of the MRP summarize the acid and toxic nature of the Hiawatha Coal Seam in the CIA. The acid base potential of each of the three coal samples collected from the HZ-series holes indicate that the coal has a potential to be acid-forming, with values from -9.1 to –15.8 tons CaCO₃ per 1000 tons of material. Coal sample analyses show total sulfur contents from 0.38 % to 0.61 %, of which 0.02 % to 0.07% is pyritic sulfur. Overburden and underburden have a high neutralization potential (20.3 to 64.0 tons of CaCO₃ per 1000 tons), although one roof sample from LMC-4 contained 0.24 percent pyritic sulfur.

Water Quality Impacts

Changes in ground-water quality may occur through contamination from acid- or toxic-forming materials and hydrocarbons, chemicals, or other materials associated with mining activities. Changes in surface-water quality may occur due to contamination from: acid- or toxic-forming materials; hydrocarbons, chemicals, or other materials such as rock dust associated with mining activities; increased sediment yield from disturbed areas; flooding; or streamflow alteration.

Increased Sediment Yield from Disturbed Areas.

Sediment yield is one of the major problems identified for any construction or development project. Exposed soils are susceptible to erosion. Developing mines and operating mining equipment at mine sites exposes soils to the elements, creating dust and mud that can be washed off site. Under SMCRA, mining operations are required use sediment control structures to divert undisturbed flows away from the disturbed areas, control disturbed area runoff, and capture sediments to prevent them from leaving the disturbed area of the minesite.

Mining activities in the CIA have a potential of contributing sediment to Jewkes Creek and the North Fork of Gordon Creek. Recent logging activities caused a large amount of sediment to flow onto the permit area. With the end of logging, this impact has continued but at decreased rates.

The Gordon Creek #2, #7, and #8 Mines are under reclamation. Some contributions of sediment may be expected from this area until the vegetation is adequately established at the site. Presently most disturbed area sediment reports to sedimentation ponds on site. One small area does not report to the pond and has proposed alternate sediment control measures. The Gordon Creek #3, and #6 Mines have met all requirements for reclamation, including a 10-year bond period, and have received bond release. The permitted land has been returned to pre-mining conditions and turned back to the landowner.

Acidity

Acid forming discharges are uncommon in the region and acid forming materials are not known to be extensive in Utah coal mines. Past mining practices have probably increased alkalinity rather than increased acidity. Coal will be in contact with air and water during the
mining operations, including coal left underground, which could potentially lower the pH in those waters. Currently, water from the old Blue Blaze No.1 mine workings has a pH of 6.8 to 7.66. In general, these are lower than pH values in the surrounding area, but do not fall into a range where the pH would affect use of the water.

Coal will be stored on the surface for short periods at the Horizon Mine. Runoff from the coal stockpile will be routed through the sedimentation pond where it will mix with more alkaline runoff from the mine pad should pyrite in the coal cause pH to decrease locally. Downstream mixing with higher pH waters would minimize or eliminate off-permit impacts.

Storage of coal in the mine yard will be short-term. All runoff from the mine yard reports to the sediment pond. Coal fines that are washed from the stockpile will be stopped at the sediment pond and will be subject to the same testing, treatment, and disposal as the rest of the sediment. If precipitation produces acidic runoff from the coal stockpiles, it will tend to be neutralized by the alkaline nature of the mine yard substrate.

**Total Suspended Solids**

A probable consequence of surface disturbance is increased sediment loading and increased total suspended solids (TSS) in runoff from the disturbed area. All runoff from the Horizon mine yard reports to the sediment pond, which is constructed to contain runoff from the 10-year, 24-hour storm event. The UPDES permit for this pond allows a maximum 70 mg/L TSS daily, 25 mg/L for a 30-day average. The Division’s database shows this pond has discharged twice since 1996, and UPDES limitations were met.

**Total Dissolved Solids**

Contact between disturbed area runoff and materials exposed to weathering and oxidation, drainage from coal refuse and mine waste storage areas, and discharge of excess mine drainage may result in increased TDS and an increase in individual constituents. Potential increases may be effectively addressed on a short-term basis by establishment of the drainage and sediment control system and through compliance with discharge effluent limitations of the UPDES permit. The present permit limitations for TDS discharged from all mine water and decant operations is limited to 1 ton per day to Jewkes Creek.

**Other Materials Associated with Mining**

The road to the mine is maintained as a gravel road; therefore, the use of road salting is not likely to affect water quality. However, the county has requested magnesium chloride as a road dust suppressant, which may increase the magnesium present in the system. No longwall mining is proposed so spills from longwall mining fluid are not expected. If calcium sulfate were to be used as rock dust, an increase of sulfates could occur in the surface waters or waters discharged by springs below the mine, but this is not expected to occur. Calcium carbonate is to be used for rock dust in the Horizon Mine, so the general signature of the calcium bicarbonate type water should not change.
Hydrocarbon Contamination

Diesel fuel, oils, greases, and hydrocarbon products will be stored above ground and may be spilled in the mine and on the surface during mining operations. Proposed concrete containment structures and Spill Prevention and Contamination Control Plan will minimize the potential for impacts.

Flooding or Stream Flow Alteration

The potential for flooding within the disturbed area and downstream is diminished by using the sedimentation pond to attenuate peak flows. Upstream drainages are transported underneath the Horizon pad through bypass culverts designed to safely pass the peak flow from a 100-year, 6-hour event. It is likely that the water flowing through the culvert will have increased flow velocity over the natural velocities for the same discharge rates, so operational designs include a discharge pool downstream of the sedimentation pond and riprap at the culvert outlet to prevent streamflow alteration. The reclamation of Portal Canyon will return the ephemeral flows from this canyon directly to Jewkes Creek. The reclamation channel will be designed to encourage development of riparian vegetation in Jewkes Creek. Other potentials for streamflow alteration include an increased discharge through the operation period due to mine dewatering. This flow may promote downstream vegetative growth that may encourage stability during the operating phase.

Past mining has caused a reduction in streamflow. The Sweets mine is suspected to be intercepting surface waters in Bryner Canyon at the #2, #7 and #8 mine. It is not known where this flow re-issues but it is suspected that it may re-issue in Sweets Canyon. This reduction has not been determined to have resulted in contamination, diminution, or interruption of a water supply.
VII. MATERIAL DAMAGE DETERMINATION

The material damage determination is based on the past, present, and expected mining and the associated changes that may be expected to occur to the water resources from mining operations. These changes constitute material damage if the change causes the loss of a legitimate use in quantity or quality. Replacement or mitigation for a legitimate use may result in no net loss of the legitimate use. Criteria that are used to determine material damage to hydrologic resources in coal mining programs administered by other states or by the Federal Office of Surface Mining (OSM) include:

- Actual or potential violation of water quality criteria established by federal, state, or local jurisdictions.
- Changes to the hydrologic balance that would significantly affect actual or potential uses as designated by the regulatory authority.
- Reduction, loss, impairment, or preclusion of the utility of the resource to an existing or potential water user.
- Short term (completion of reclamation and bond release) impairment of actual water uses that cannot be mitigated.
- Significant actual or potential degradation of quantity or quality of surface water or important aquifers.

Each factor addressed in the Probable Hydrologic Impacts that may affect a water use will be discussed to indicate whether material damage is expected to occur to a legitimate water use. The reasons for the determination of potential for risk to a water use is discussed further.

Adverse Impacts to the Hydrologic Balance:

Ground-water Regime

Although fracturing and faulting is abundant in the CIA, mining of areas adjacent to a water-bearing fault have been indicated to be dry. Mining through water-bearing faults near the Gordon Creek #2 mine has not resulted in any documented loss or dewatering of springs in the CIA. One fracture associated with well HZ-95-1 will be undermined but no documented springs are associated with that fracture. A change in the piezometric surface may dewater springs issuing from the Star Point in Coal Canyon and the canyon west of Coal Canyon; however, it is not known whether these springs are in hydrologic connection with the area to be mined. If the spring water were in connection with the mine, the water pumped from the mine probably would offset the losses from the springs. Due to the location and elevation of the fractures relative to mining, it is likely that water would re-issue from the springs when the potentiometric surface recovers following mining. Therefore, no material damage is expected to occur to the quantity of downstream water use.
Increased Discharge in Springs

Increases in discharge of springs below the coal to be mined is possible following mining but is less likely to occur during mining. Dewatering of water-bearing zones that do not issue to surface springs or increased hydraulic connection to aquifers above the coal may increase discharge. Increased discharges may have occurred along a fracture in Coal Canyon as evidenced by a vegetative change to wetland species in the discharge area. Increased discharges have not been demonstrated to adversely affect quantity of legitimate water uses. (Increased ground-water recharge and discharge are considered to have similar results).

Change in Location of Spring Discharge

Changes in location of discharge might occur at low points of fractures and below the mined area. Currently new springs have issued in a drainage west of Coal Canyon. It is probable that these springs are discharging from a flooded, mined-out, area.

Changes in spring locations may also occur due to subsidence. The perched aquifers of the Blackhawk Formation are lenticular and localized; the stratigraphic sequence has overall low permeability. If fractures reach the surface the springs may be readjusted and discharge at another surface location. Past experience presented no documented cases of relocation of springs due to subsidence. Because the Blue Blaze #3 Mine has already mined above much of the area where the Horizon Mine workings will be, it is expected that subsidence is not likely to cause material damage.

Increased Ground-water Recharge

Propagation of subsidence to the surface could result in increased recharge. Increased recharge to the Sweets Mine has probably occurred through surface-water interception along Bryner Canyon. This area has been mined with little overburden. The proposed Horizon mining operations have a greater depth of cover, and mining of the Castle Gate A and Hiawatha Seams with similar overburden has not resulted in any documented cases of subsidence fractures. Increases in recharge to the aquifers above the coal is not likely because those aquifers influenced will probably drain to the mined area. Increases in recharge of aquifers within and below the coal is likely, but has not adversely effected the quantity of the proposed use.

Changes in Hydraulic Conductivity

Changes in hydraulic conductivity may change the timing and rates of discharge to springs and surface waters. With an increase in hydraulic conductivity, the high-flow periods could potentially flow at greater rates, leaving less water available for low-flow rates. Because the stratigraphic sequence has a low overall permeability and is interbedded with clays it is expected that any increase in hydraulic conductivity above the coal would eventually decrease over time. The hydraulic conductivity of the mined areas of the coal seams will change. These areas will fill with water and the head will come into equilibrium with the rate of recharge. Because no significant baseflow contributions from the coal seams have been identified, it is not expected to have an impact on the surface water in the area following mining and establishment of a new equilibrium with the ground-water system.
Surface-water Regime

Jewkes Creek may see increased flows during the period of mining operations due to mine dewatering. The predicted inflows and predicted use suggest this value will change by approximately 50 gpm. The sumping operations and use and consumption of water in the mine will dictate the rate of discharge. In most mining operations this has increased water availability during low flow. Thus, no impacts to quantity for a legitimate water use have resulted during operations. Following operations the discharge rates will occur in equilibrium with the system. No losses of quantity of use have been documented for the areas that have previously been mined. Therefore, it is expected no material damage will occur in the future.

Beaver Creek is located above the area to be mined by the Horizon Mine. Approximately one mile of the Beaver Creek stream channel was previously undermined by mining in the Bastleate A Seam at the Consumers #3 Gordon Creek #2 Mines. Limited data are available, but no loss of flow over time has been documented; however, a citizen’s complaint has indicated that mining has decreased flows in the stream. The first year of monitoring is established to further assess this potential. The fact that the stream is presently flowing indicates this activity probably will not completely deplete surface flows in Beaver Creek. However, increased vertical flow rates could reduce surface flow and would be controlled by the hydraulic conductivity of the alluvium and lower water bearing zones. The rate of increased discharge, if any, would be controlled by the system and could not be predicted.

The North Fork of Gordon Creek has been monitored below the Gordon Creek #2, #7 and #8 Mine. The Sweets mine is suspected to be intercepting surface waters in Bryner Canyon at the Gordon Creek #2, #7 and #8 Mine. It is not known where this flow re-issues but it is suspected that it may re-issue in Sweets Canyon. The water in the North Fork of Gordon Creek has not been determined to result in contamination, diminution, or interruption of a water supply; therefore, no material damage has been identified. Future mining may change the location of discharge to the stream but is not expected to cause material damage.

Surface-water Quality

Water quality is outside the permit boundary is expected to be the same as presently observed. One reason for this assessment is the large extent to which mining has occurred in the past without producing known impacts to the water quality; however, historical baseline information is not available because mining occurred in this area prior to the enactment of SMCRA, therefore, the changes that may have occurred due to mining cannot fully be assessed. No material damage to quality or loss of use has occurred in this area and is not expected to occur.
VIII. STATEMENT OF FINDINGS

Mining in the federal lease north of Beaver Creek will likely intersect faults and undermine Beaver Creek as well as some springs. Development of the Horizon Mine will include monitoring adequate to identify impacts to the hydrologic balance and contamination, diminution, or interruption of water supplies. Available information indicates that impacts to the hydrologic balance from past mining have been minimal and that there is a very low probability that any streams or springs will be affected during this permit term as a result of mine subsidence. Evaluation of the data and information received from Hidden Splendor Resources, Inc. as well as analyses of germane studies and reports from other sources leads the Division to find that no material damage will occur to the hydrologic balance outside the permit area as a result of mining the federal lease.
APPENDIX A

Figure 1  Cumulative Impact Area
Figure 2  Location Map
Figure 3  Geologic Map
Figure 4  Mine Map – Castlegate A Seam
Figure 5  Mine Map – Hiawatha Seam (Wattis)
Figure 6  Hydrologic Map
Figure 7  Watershed Boundary Map
REFERENCES


Mountain Coal Company (Amax Coal Company), Gordon Creek #2, #7 and #8 Mining and Reclamation Plan.

___________________, Gordon Creek #3 and #6 Mining and Reclamation Plan.


REFERENCES


Western Regional Climate Center (WRCC), http://www.wrcc.dri.edu

O:\CHIA\CHIAS\UpperGordonCreekAndBeaverCreekBasin\Final\06132005\06132005.doc
Figure 5
Cumulative Hydrologic Impact Assessment
Horizon Mine

MINE MAP - HIAWATHA SEAM (WATTIS)

File: P:\GROUPS\ALLOGM\GIS\coal\ciamaps\HorizonFig5.mxd
Compiled by AM  Date: May 26, 2005